POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

ELY C. HUTCHINSON, *Editor*

Volume 72 NEW YORK, JULY 15, 1930 *Number 3*

The Problem of the Aged

HENRY FORD has found no occasion to change his previously expressed opinion that if all the men of fifty-five years and older were removed from industry there would not be enough brains left to carry on.

"Young men are the best executives," says Mr. Ford, "but the best plans originate in older heads."

This is quite obvious as applied to the responsible leaders of industry, the thinkers and planners, the generals. They ought to improve with experience, and their function does not depend upon unimpaired physical prowess.

But they make up a small proportion of those who must grow old working for a living. What about the veteran in the ranks who finds the pace too fast, the march too long, for his failing powers?

The man over forty who is forced to seek a job finds himself seriously handicapped, especially if his work is of the repetitive sort where experience does not count.

Employers prefer men with a longer expectancy between their first pay envelope and their transfer to the pension list.

The mechanization of industry, the application of science to management, the abundant use of power have reduced and are still reducing the number of man-hours required to do the work of the world.

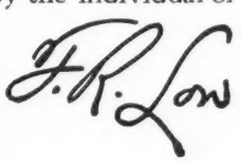
For those who depend upon working for a living this can mean but one thing if they are to have a chance.

And that is that fewer hours of work out of each man's life must pay his passage from birth to death.

It may be fewer hours a day, fewer days a week, fewer years of service, later beginning and earlier retirement.

But this lessened proportion of his waking hours spent in toil has got to pay not only his expenses while working but cover the spread from the helplessness of childhood to the incapacity of age.

The problem is that of the equitable distribution of the products of labor and of the conservation by the individual of the surplus of his productive years for the support of his years of dependency.



EDITORIALS

A Fast Life Need Not Be a Short One

TWO WEEKS AGO an editorial in these columns was devoted to the folly of building massive slow-speed long-life machinery when the purchaser bases his calculations on a five-year machine life.

The suggestion that machines should be built light in weight for high speed carried with it the intimation that high speed is accompanied by a short life.

But is a fast life necessarily a short one?

It is a matter of ordinary observation, for example, that many high-speed gasoline engine types do have a short life. Indeed the working life of the average automobile engine is somewhat less than three thousand hours. But this is by no means a proper criterion, for the engine is bound up inextricably with the chassis and the driver's lack of judgment. If the engine were not abused it would have a life expectancy far beyond that of the body and frame, and often far beyond the life realization of the careless driver. In fact, the engine is subject to an abuse that is limited only by the ability of the owner to discover new punishment with which to burden the machine until it finds an unglorious end at the town dump.

The same engine would have lasted ten times as long if it had been placed on a substantial foundation and under the eye of a mechanically minded engineer.

Few high-speed machines fail from pure wear, and almost always the deterioration is due to overstressing of the metal; in the attempt to achieve high speed and light weight designers have been proved to barely skirt the stress danger point, and the machine fails from high pressures.

A high-speed machine when properly designed can operate with reasonable stresses, so that its life is not influenced by this factor. It is true that high inertia forces usually accompany high-speed, but numerous light alloys are now available, so that this difficulty is avoidable.

Mere wear of moving parts has never been a decisive factor, although it is a general but mistaken belief that wear varies directly with the relative velocity of the parts. If advantage is taken of modern lubrication methods and bearing materials, including nitriding and other hardening processes, a high-speed machine should function satisfactorily for years.

This, however, does not destroy the argument that engine designers should adopt high-speed designs to meet modern merchandising requirements. Even if it has an equal life, a high-speed machine can usually be built much more cheaply than can its slow-speed progenitor. It is time that machinery is speeded up to meet the fast pace of modern life.

Water Level Measurement

THE advent of pressures in the neighborhood of 1,200 and 1,400 lb. has accentuated the necessity of changing the present method of indicating boiler water level. Operators of high-pressure boilers report that the difference in density between the hot water in the boiler and the cooler water in the column causes the water column to indicate a level lower than actually exists in the boiler. The difference in level in a gage glass before and after blowing down the column has in some cases amounted to as much as five inches. This condition has a tendency to cause high water during normal operation.

Both manufacturers and operators have felt the need of something other than a gage glass for indicating boiler water level, even under moderate pressure conditions, but the strict requirements have made the search not an easy one.

Devices for indicating boiler water level are available, but either because these have not fulfilled all requirements, or because of state boiler regulations, none has completely replaced the gage glass.

American engineers have been notably successful in overcoming many of the difficulties formerly associated with the operation of high-pressure boilers. Surely the problem of water level measurement will yield to their directed efforts. Incidentally, developments along this line might also find application in low-pressure boilers.

The Search for Perfection

"ANYTHING worth doing at all is worth doing well." This old saw has served a useful purpose. It has also done some harm. Its chief service has been in battling the sloppiness and inertia inherent in most men. One must be able and willing to take infinite pains to secure a certain result when the occasion requires superlative workmanship.

The harm in the indiscriminate application of this proverb comes from the belief, common in some circles, that everything should be of the finest workmanship. Carried to its logical conclusion, this may become absurd. Common sense will tell one that while ten thousandths of an inch is none too close for some purposes such tolerances are not required in baseball bats and crowbars.

In spite of the abuse which moralists have heaped on the expression "good enough," it is exactly right if taken at its face value. It is a fundamental principle of economics—one known to every competent engineer—that increasing expenditures of time or money bring results that increase more and more slowly until a point is reached where further expense and effort will not pay. Using this principle, one may compute the economic thickness of heat insulation, strength of machine parts, etc. It needs to be more widely understood and applied.

But those who apply this principle must learn to beware of its pitfalls. "Good enough" does not mean "good enough to 'get by'" or "good enough to work after a fashion." Rather does it mean "good enough to represent the best possible investment of time, labor, and material." Anything short of that is an economic crime to be condemned with the other extreme of needless and wasteful "perfection."

Mills for Pulverized Coal

THE MILLS first used in central stations for pulverizing coal were small units of five to seven tons, capacity each. Wear and tear was high. In operation they were extremely noisy—an indication that much mechanical effort was utilized ineffectively. Lubrication methods were poor, and shutdowns were frequent for lubricating the parts and for cleaning out wet material.

An increase in mill size brought about many improvements. Automatic lubrication systems were developed and operating periods lengthened. It was found that if the coal was furnished in smaller sizes, the output was increased with less power per ton of coal.

Use of preheated air to dry the coal in the mill has been effective in overcoming former troubles from moisture in mill bottoms and from condensation during transport of the powdered coal. Mill drying is now generally favored. Furthermore, the larger mills operated at lower speeds and were less noisy in operation.

Introduction of mill drying and coal sizing on these new mills has resulted in large increases in capacity. For instance, a fifteen-ton mill has produced twenty-five tons per hour and a twenty-five-ton mill has delivered thirty-seven tons of pulverized coal.

These figures suggest that there are some further factors in drying, coal sizing, grinding, and dust removal from mills now used for pulverizing coal that deserve further study. When the influence of each of these factors is properly evaluated, it is probable that additional improvements can be made and greater capacities obtained from the new construction.

While rapid progress has been made since the days of the early mills, there is still a fruitful field for further experimentation which will result in mills of still larger capacity that require fewer kilowatt-hours to grind a ton of coal.

"The Proof of the Pudding"

IN THE power plant the proof of the design and any particular arrangement of equipment lies in the performance, maintenance, and availability records. Such data are available less frequently than might be desired. Attention, therefore, is directed to an article in this issue dealing with these factors. The article in question refers to Mad River station of the Ohio Edison Company, following an initial description of the plant published nearly three years ago. The author reviews the results obtained for the past two years, gives an excellent idea of the relative importance of the various items entering into the operating expense, outlines his maintenance problems, and summarizes the availability of the equipment.

Considering the size of the plant and the period load factor, excellent results have been obtained. Other plants may be doing as well, and the operating experiences in them may differ. It is certain that reviews of their performances would be of definite value. Contributions of this character will be welcomed.

▼

POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

▼

Advanced Engineering Lowers Power Costs

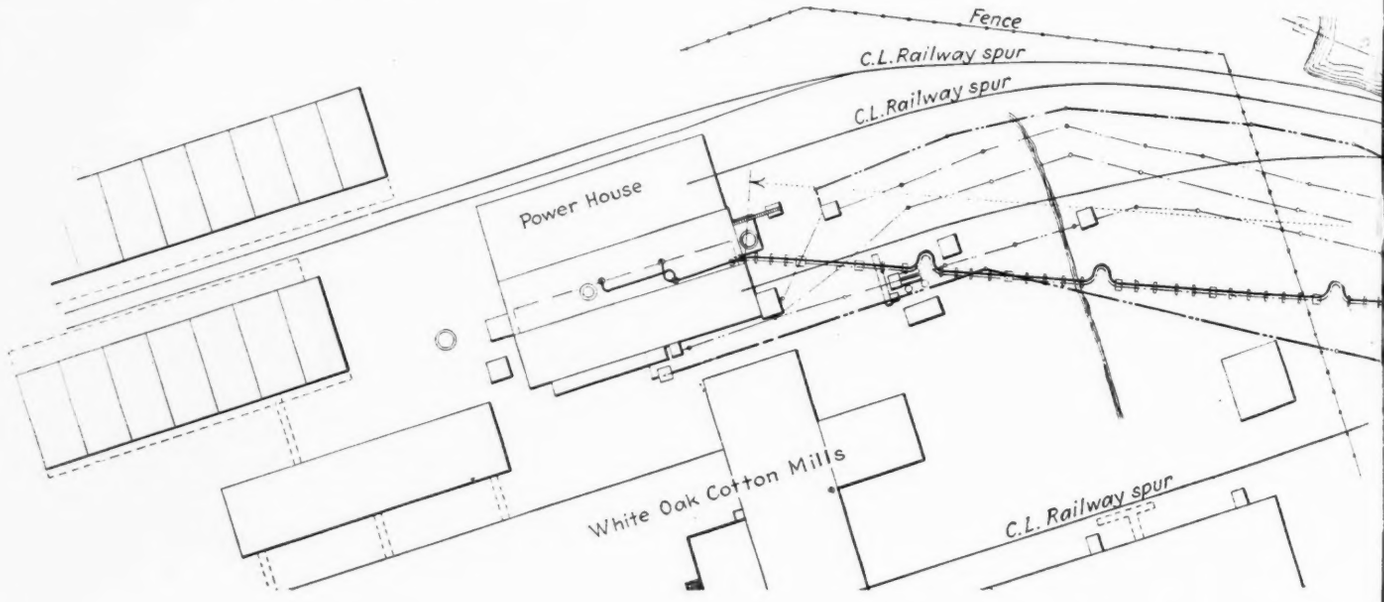
At Proximity Manufacturing Company

By L. H. MORRISON
Associate Editor of POWER

THE COMPLETE RECONSTRUCTION of the power and process steam supplies at the Proximity Manufacturing Company, Greensboro, N. C., has enabled the cost of power and steam to be so reduced that the entire expense of reconstruction will be paid for in five years. The new plan includes generation of steam at 450 lb., development of power in bleeder turbines, and conveyance of 150-lb. bled steam a distance of about one-half mile, where the steam is put through a second turbine and then withdrawn at 13 lb. for process. These two plants are electrically connected with a third, which has both boilers and a turbine, and operation is such that at all times a minimum amount of steam is sent to the condenser and a minimum amount of live steam is used in the processes.

The three plants embraced in the power plan are the Proximity mills, making denim cloth; Proximity print works, engaged in cloth printing and dyeing; and the White Oak mills, manufacturing denim cloth. In addition the same company operates the Revolution mill, which makes cotton flannels.

Originally the White Oak mills were powered by four 30x60x60-in. cross-compound corliss engines direct con-



Views of the 14-in. overhead steam line from White Oak Cotton Mills to Proximity Print Works

▼

nected to 1,500-kw. 40-cycle alternators. Steam was supplied by ten 2,500-sq.ft. and twenty 2,080-sq.ft. longitudinal-drum 150-lb. water-tube boilers, hand fired. To this equipment was afterward added a 2,500-kw. condensing turbine served by a low-head barometric condenser. As the equipment was insufficient to supply needed power, about 1,500 kw. was purchased, being changed from 60 to 40 cycles by a frequency changer.

The conditions existing at the time the new power study was initiated is outlined in the tabulation:

	Proximity	Print Works	White Oak
Process steam.....	Live steam	Live steam Bled steam	Live steam
Power	Purchased	Generated in extraction turbine	Generated in condensing units
		Purchased	Purchased

At the print works there were a 750-kw. bleeder-type turbine and two 2,500-sq.ft. and two 4,350-sq.ft. boilers. This equipment gave insufficient power, so some energy was purchased. As the transmission company was unwilling to operate in parallel with the mills' plants, the purchased energy was used in departments not served by the latter.

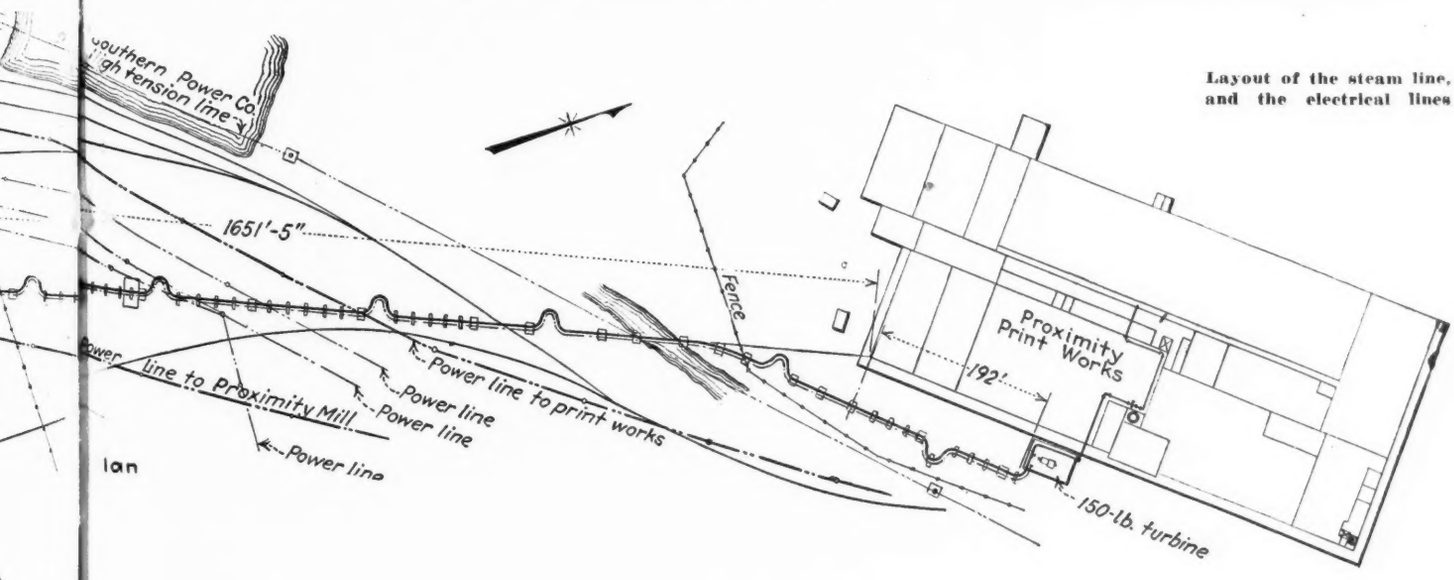
The Proximity mills originally purchased all power, and process steam requirements were met by live steam from four hand-fired water-tube boilers. Later a 1,000-kw. bleeder turbine and a 7,790-sq.ft., 250-lb., stoker-fired boiler was added.

At the Revolution mill, which at present does not enter into the final power supply arrangement, live steam is used for processes and all the power is purchased.

Obviously, the arrangements for power and process steam were not economical, for individual mill requirements had been met from time to time by additional equipment, without regard to the combined needs of the three mills.

In order to co-ordinate the mills' power and steam sources, the Proximity Manufacturing Company employed J. E. Sirrine & Company to undertake a comprehensive survey of the situation with a view to finding the most efficient method of obtaining power and process steam.

Early in the study it was found that either of two plans would reduce costs below those existing at that time. The first plan embraced the construction of a central power station between the Proximity print works and Revolution mill, to supply all power needed by the four mills through a transmission line and to furnish all process steam needed by the mills by means of an over-



Layout of the steam line, and the electrical lines

head pipe line, with steam bled from the generating units. This plan would have entailed construction of an entirely new power house; and the fixed charges on the additional investment were not justified by the probable reduction in operating charges below those to be obtained with the second plan, which was finally adopted.

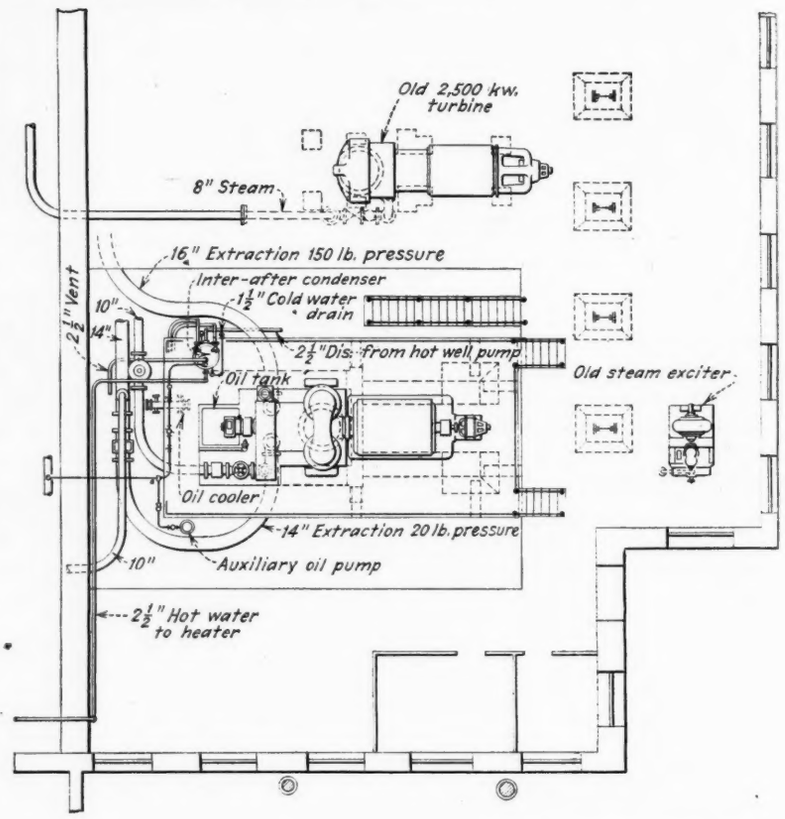
The second plan involved the use of the existing plant building at the White Oak mills, thereby avoiding a large building item; installation of a two-point bleeder turbine; abandonment of the corliss engines and the hand-fired boilers; and installation of new high-pressure boilers. At the Proximity print works a small power house was to be built to accommodate a 1,500-kw. bleeder turbine, arranged to take steam at 150 lb. from a 2,080-ft. long pipe line from the White Oak mills. A transmission line would interconnect White Oak, Proximity print works and Proximity mills, and the turbines in the latter two would be operated up to a point where the throttle steam would be just sufficient to meet process demands. The remainder of the power would be furnished by the White Oak plant, which would have a 3,500-kw. turbine bleeding at 150 lb. to supply the pipe line to the print works and at 13 lb. to supply White Oak with its process steam; while the old turbine would receive its steam from the low-pressure header supplied either through a reducing valve from the 450-lb. line or from the 150-lb. bleeder line. This plan was adopted. It has now been functioning long enough to demonstrate its soundness.

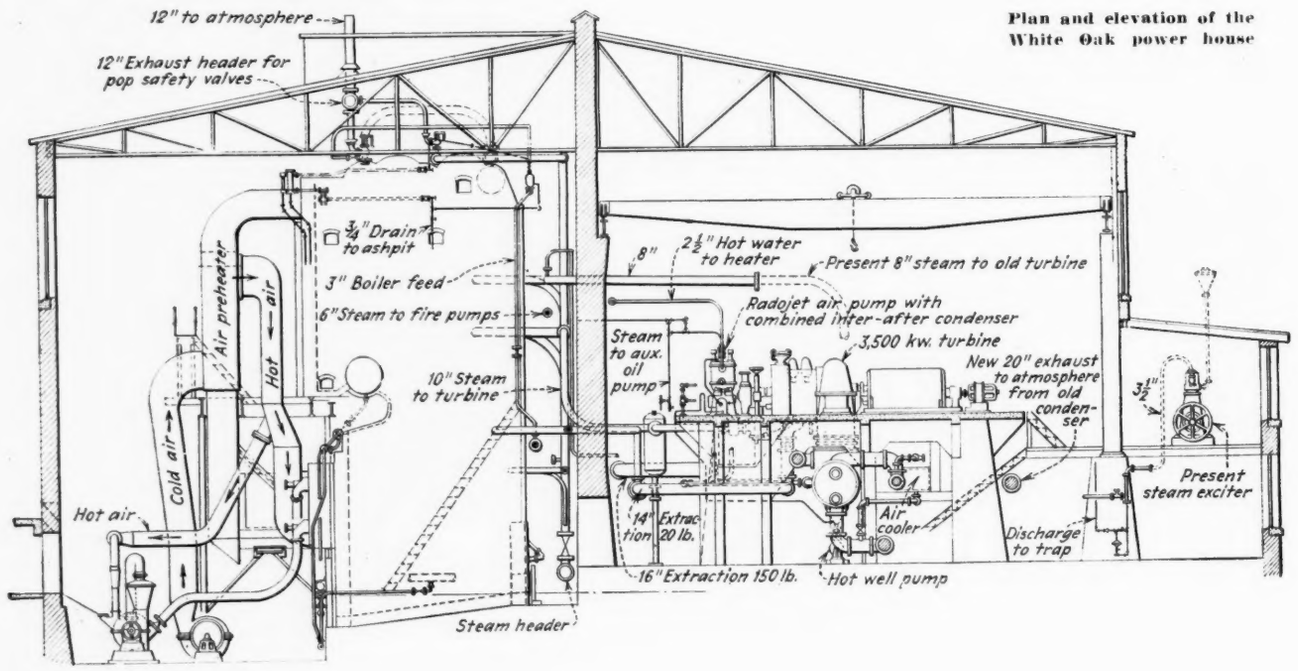
It will be seen that in the latter plan the Revolution mill is ignored. At present the mill buys all its power and uses hand-fired boilers for process steam. It is probable that at some time in the future the 2,080-ft. steam line and the interconnecting electrical lines will be run to Revolution.

White Oak power house is the most interesting, as it is the main plant and is the control point of the system.

To accommodate the two new 450-lb. boilers twenty of the hand-fired units were removed, ten being retained for emergency. As the height of the room was insufficient to accommodate the new vertical water-tube boilers, it was necessary to excavate several feet, as shown in the building elevation view. Each boiler is provided with fin-type water walls on all four sides of the furnace and is equipped with sufficient superheating elements to give 200 deg. of superheat at maximum rating.

As one of the boilers operates on a 24-hr. schedule the engineers felt that pulverized coal would work out more satisfactorily than stokers, although at the Proximity mill the two boilers last installed are stoked, operating as they do only ten hours a day.





Plan and elevation of the White Oak power house

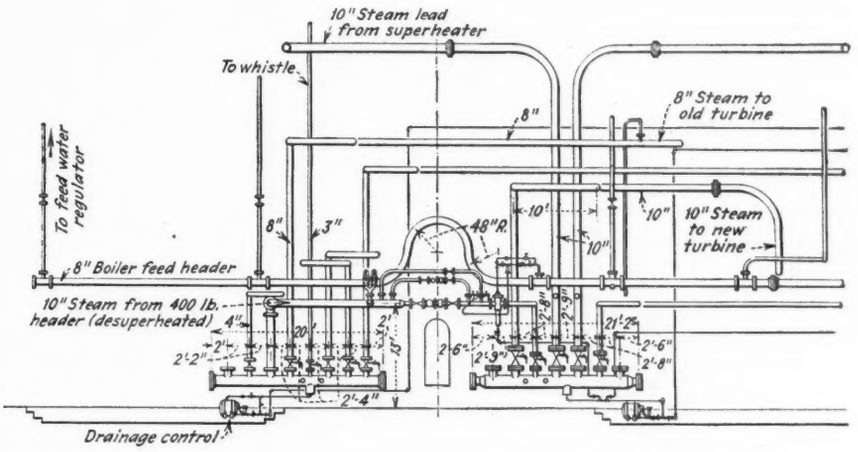
Each boiler is fired by two burners, each connected to a 5,000-lb.-per-hour unit pulverizer. In addition there is a cross-connected 2,500-lb. pulverizer that can supply either boiler in event of emergency. Starting a fire is accomplished by a kerosene lance-type burner.

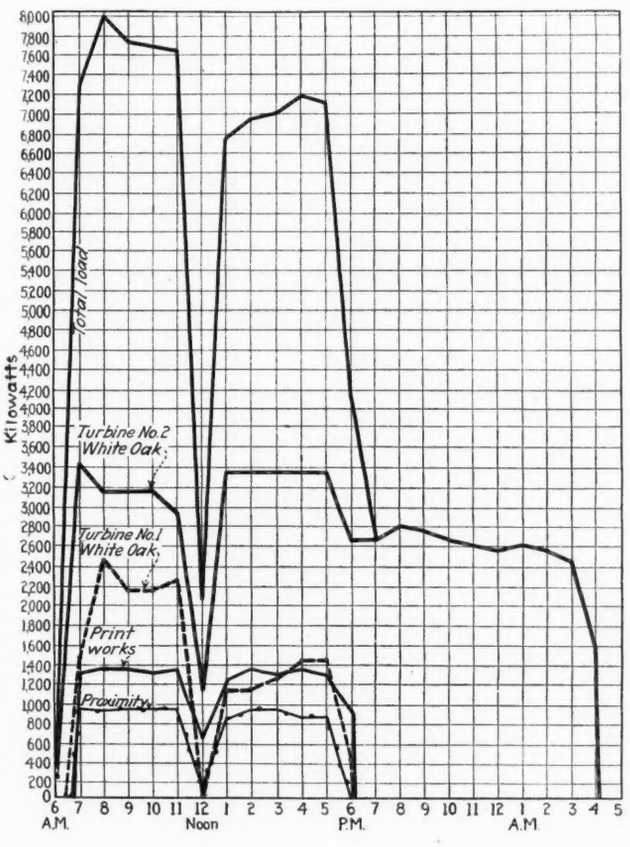
As will be seen from the load curves, the boilers operate over a wide range, but no difficulty has been experienced with blow-backs at the burner on light loads.

Air preheaters are used in preference to economizers.

Interconnections of the high- and the low-pressure header

Daily load curve of the three mills





These are of the plate type, with the induced-draft and forced-draft fans motor driven. Efficiency of the heaters is excellent. Typical readings of the temperature recorders are:

Gas in, deg. F.	535
Gas out, deg. F.	400
Air in, deg. F.	80
Air out, deg. F.	400

The boilers and their equipment were purchased as a unit, with a total over-all guaranteed efficiency for each boiler as follows:

Evaporation, Lb. per Hr.	Over-All Efficiency, Per Cent
50,000	87
75,000	85½

Maximum output was set by the boiler manufacturer at 90,000 lb. per hour, but in every-day operation as high as 120,000 lb. has been generated in one boiler. Average monthly efficiency, including losses due to week-end shutdowns, is 83½ per cent, which, in view of the varying load during a 24-hr. period, is remarkable.

Coal is obtained from Kentucky, Tennessee, and West Virginia, and after being dumped from the car is handled by a monorail hoist to the screens over the coal chutes leading to the automatic scales. This trolley runs outside the building and was adopted because of the sharp curves in the track. No crusher is needed, as a plentiful supply of slack is available at all times.

Furnace ash and slag are recovered by a hydro jet. Originally the furnaces had flat bottoms, but after a short period of operation the lining was altered to give a double-V or hopper effect. Although initially some trouble was experienced with fly ash from the stack, which is the one originally in the plant and is of brick 12 ft. diameter x 200 ft. high, slight alteration in the baffling eliminated this trouble, and the stack top is noticeably free from haze.

Boiler feed consists, in the main, of condensate returns from the process lines, but about 25 per cent is make-up. This comes from the company's water supply, which has its source in a large storage reservoir that provides treated water for the villages around the mills as well. The boiler make-up is first given a zeolite treatment, and with a view of preventing caustic embrittlement tri-sodium-phosphate is added to maintain zero hardness. The water then passes to the storage tank and to deaërating feed-water heater, placed near the top of the boiler room. Condensate returns enter the storage tank below the heater and are put into the heater as required. This heater operates under a pressure of 13 lb. per square inch and is provided with a vent condenser.

Two 5-stage centrifugal pumps feed the boilers. They are direct connected to turbines supplied with 450-lb. steam at the throttle and exhaust at 13-lb. back pressure. The exhaust steam is passed to the heater, and any deficiency needed for feed heating is supplied by the 13-lb. bleeder line from the main turbine.

A complete equipment of instruments for reading

Principal Equipment in Proximity Manufacturing Power Plants

WHITE OAK MILLS

Boiler Room

Boilers, two, 8,630-sq.-ft., V-type, 445-lb. Heine crossdrum, Combustion Engineering Corp.
Superheaters to give 200 deg. of superheat, Combustion Engineering Corp.
Water walls, fin type, 1,516-sq.ft. of walls and 220-sq.ft. of screen ..... Combustion Engineering Corp.
Soot blowers ..... Diamond Power Specialty Corp.
Steam purifier ..... Blaw-Knox Co.
Safety valves ..... Ashton Valve Co.
Blow-off valves ..... Yarnall-Waring Co.
Feed water regulator ..... Stets Co.
Draft gages, recording meters for steam flow and gas and air temperatures ..... Bailey Meter Co.
Ash removal ..... Allen-Sherman-Hoff Co.
Water columns ..... Yarnall-Waring Co.

Coal Handling

Coal hoist, monorail type ..... Cleveland Electrical Tramway
Coal scales, four, automatic ..... Richardson Scale Co.
Coal pulverizer, four 5,000 lb., one 2,500 lb., Combustion Engineering Corp.
Coal burners, two per boiler, couch type. Combustion Engineering Corp.
Air preheater, plate-type, 12,880 sq.ft. each, Combustion Engineering Corp.
Induced-draft fans, two 77,000-c.f.m., direct connected to 125-hp. variable-speed G.E. motors ..... American Blower Co.
Forced-draft fans, two 32,000-c.f.m., direct connected to 100-hp. G.E. motors ..... American Blower Co.

Feed Water System

Heater, deaërating type ..... Cochrane Corp.
Feed pumps, two 5-stage, 450-g.p.m., 1,086-ft. head; direct connected to steam turbines ..... DeLaval Steam Turbine Co.
Water softener ..... Permutit Co.

Turbine Equipment

Turbine, one 2,500-kw. condensing, and one 3,500-kw. double-extraction ..... General Electric Co.
Condensers, on 2,500-kw. turbine, low head barometric; on 3,500-kw. turbine, two-pass surface type, 48,000 sq.ft., 1,146 Muntz metal tubes ..... C. H. Wheeler Mfg. Co.
Air pump, duplex radojet ..... C. H. Wheeler Mfg. Co.
Condensate pump, one 2½-in., 2-stage, 125-g.p.m., 85-ft. head centrifugal direct-connected to 1,800 r.p.m., 10-hp. G.E. motor, C. H. Wheeler Mfg. Co.
Circulating water pump, one 5,700-g.p.m., 18-ft. head centrifugal directed-connected to 40-hp. G.E. motor. C. H. Wheeler Mfg. Co.
Drip traps, S-C type ..... Swartwout Co.
Reducing valves, damper-regulator-control type, Ruggles-Klingemann Mfg. Co.
Steam headers ..... National Valve & Mfg. Co.
Atmosphere relief valves ..... Atwood & Morrill
Non-return and globe valves ..... Edwards Valve & Mfg. Co.
Gale valves ..... Chapman Valve Mfg. Co.
Desuperheater ..... Elliott Co.

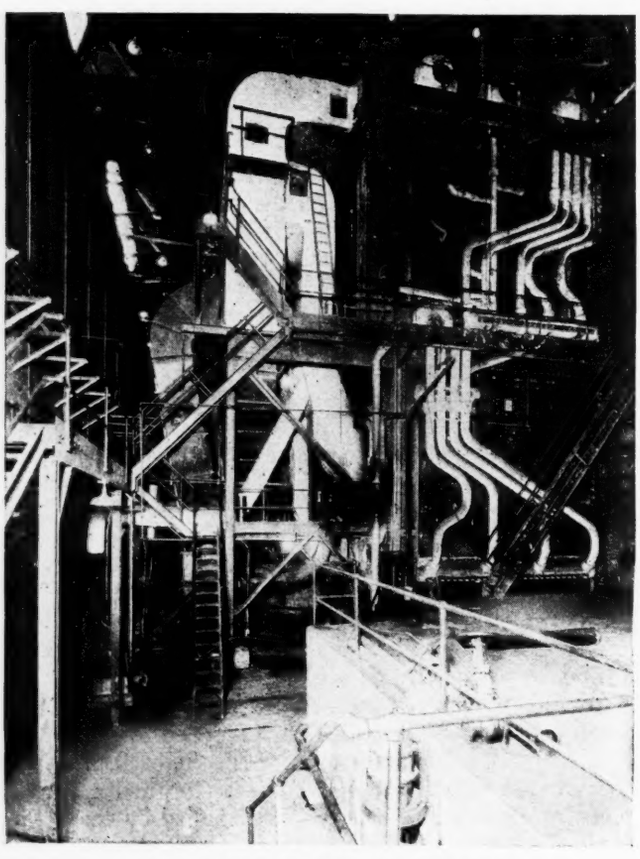
PROXIMITY PRINT WORKS

Turbine, one 1,500-kw. bleeder-type ..... General Electric Co.
Condenser, surface-type, 2,600 sq.ft. ..... C. H. Wheeler Mfg. Co.
Circulating-water pump, one 2,600-g.p.m. centrifugal direct-connected to 60-hp. motor ..... Allis-Chalmers Mfg. Co.
Condensate pump, centrifugal ..... C. H. Wheeler Mfg. Co.
Air pump, radojet ..... C. H. Wheeler Mfg. Co.
Relief valve ..... Atwood & Morrill
Piping, 2,080 ft., 14-in. O. D. with welded joints .. R. H. Baker Co.
pipe covering, 4-in. sponge felt ..... Johns-Manville Corp.

various pressures and temperatures is placed on an operating platform between the two boilers. Here also are the controls for the draft fans and coal pulverizers, steam gages and steam-flow meters.

The entire boiler room equipment has been designed with a view to reduce the labor item to the lowest possible cost. That this has been accomplished is indicated by the fact that the labor cost of the entire power plant is but 18 per cent of the plant operating costs. Two men are employed in the boiler room per shift.

The steam header design is one that is found in a number of the modern Southern plants. Each boiler is connected to a short welded header placed above the floor level at the rear of the boiler, with several welded nozzles connecting to the mains. In addition, immediately below the high-pressure header is a low-pressure header with a connecting bypass that has a controlled reducing valve and a desuperheater. The various low-pressure steam lines are taken from this header.



View of 450-lb. boiler at White Oak

In the turbine room the old 2,500-kw. condensing unit was retained and a 3,500-kw. two-point, or double extraction, bleeder turbine was installed. The latter takes steam at 450 lb., and about 60,000 lb. of steam is withdrawn at 150 lb. to supply the pipe line to the print works, and about 60,000 lb. at 13 lb. for the White Oak process lines. About 2,000 lb. passes through the low-pressure stage at times of maximum extraction to insure blade cooling. The condenser serving the 3,500-kw. unit is of the surface type, with a centrifugal motor-driven circulating-water pump, but the shaft is arranged for a future turbine drive. The air pump is of the radojet type, using condensate for the inter- and after-cooling, but with separate compartments for make-up water cooling if there is a deficiency in the condensate.

The overhead pipe line to the print works is of 14-in. O.D. pipe with electrically welded joints. This line has eight 46-ft. expansion loops. Each loop was given an initial extension of 1½ in., and after steam was turned on the total compression of the loops was 26 in. The pipe is insulated with 4 in. of sponge felt, and was covered with a waterproof jacket at the factory. When steam was turned into this pipe it was found that due to unequal heating of the pipe surface there was an upward bow of about 2 in. To avoid this, it is necessary to crack the valve and let the pipe heat up slowly.

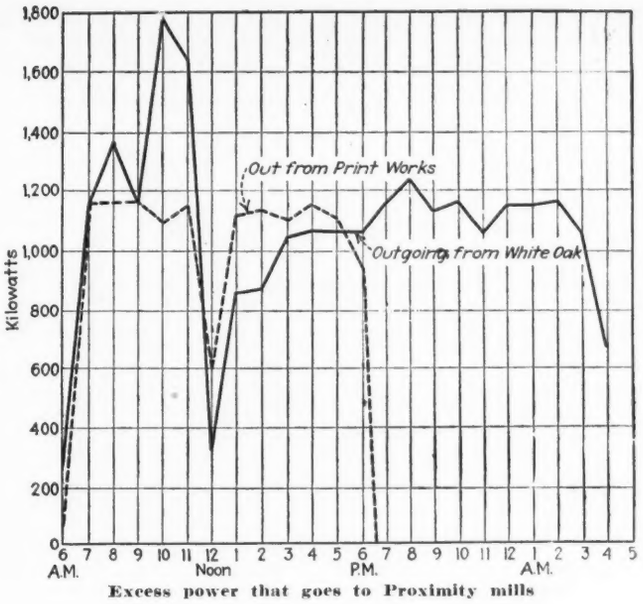
At the print works the steam is supplied to a 1,500-kw. bleeder turbine, from which 45,000 to 60,000 lb. is withdrawn per hour for processes. As the print works needs only about 450 kw. and the processes call for steam sufficient to develop 1,500 kw. before withdrawal, the excess 1,050 kw. is fed into the transmission line that connects this plant to White Oak and Proximity mills. This energy is consumed at Proximity, which generates only enough power to meet its process needs.

A bypass around the print works turbine permits steam from the 150-lb. pipe line to be passed through a reducing valve to the 13-lb. process line. To provide against back flow to the bleeder turbine there is a non-return valve in the bleeder line. Of late this valve has been interconnected by oil pressure to the turbine emergency valve, so that if the valve sticks tripping of the emergency valve will force the non-return valve closed. The turbine is served by a surface condenser, with an air-removal pump placed on the turbine operating floor.

Condensate from the print works is pumped back to White Oak in a 6-in. insulated line. Operations of the three plants are under control of the switchboard operator, or dispatcher, at White Oak, and the loads on the several machines are shifted from time to time to give the best balancing.

Obviously, the desirable situation is that in which Proximity mill generates as much power as possible from the steam needed by its process, while the print works needs less than it generates. This results in a flow of power from the print works to Proximity during the day shift.

At the same time White Oak is confronted with the problem of generating the extra power needed by Proximity and meeting the 150-lb. steam demand of the print works, as well as the 13-lb. demand of White Oak. The 3,500-kw. bleeder turbine and the 2,500-kw. condensing turbine must be operated so that the amount of live steam going to the 150-lb. line is a minimum or zero. This means that at times of a heavy demand for steam at the print works the load on the 3,500-kw. bleeder turbine must be increased to give more 150-lb. steam, and the load on the 2,500-kw. condensing turbine reduced to minimize its consumption of 150-lb. steam.



Excess power that goes to Proximity mills

The operation of this system is excellent.

In addition to the power generated by the three plants about 1,000 kw. is purchased per hour. This permits the print works and Proximity turbines to be shut down at night, as the mills work only one shift per day. At White Oak the spinning department has a night shift, as the looms have more capacity than there are spindles.

The improvements discussed were carried out by J. E. Hardin, general manager of the Proximity Manufacturing Company, and J. E. Sirrine & Company, consulting engineers, Greenville, S. C., to whom *Power* is indebted for the data presented.

▼ ▼ ▼

Installation of Synchronous Motor Solves Low-Voltage Problem

By M. M. Rose
Engineer, the Fuerst-Friedman Co.
Cleveland, Ohio

DIFFICULTY in maintaining voltage, on account of low power factor, was experienced in a laundry power plant. There were three generating units, one rated at 125 kva. 240 volts, 3 phases, 60 cycles, and one 210-kva. unit. The small machine's rating was based on unity power factor, and the other on 0.80 power factor. As the load increased a third unit, of 625-kva. rating and 0.80 power factor, was installed. The load, in general, consisted of induction motors ranging in sizes from ½ to 20 hp.

A motor-generator set was the largest unit on the system. It consisted of a 75-hp. induction motor driving a 50-kw. direct-current generator. When this unit was installed it was decided to provide sufficient capacity for any future growth in business. As a result this machine was far too large for the present load. Consequently, the motor's power factor was low, as well as that of other motors on the system. Under normal operating conditions the power factor was between 0.65 and 0.70.

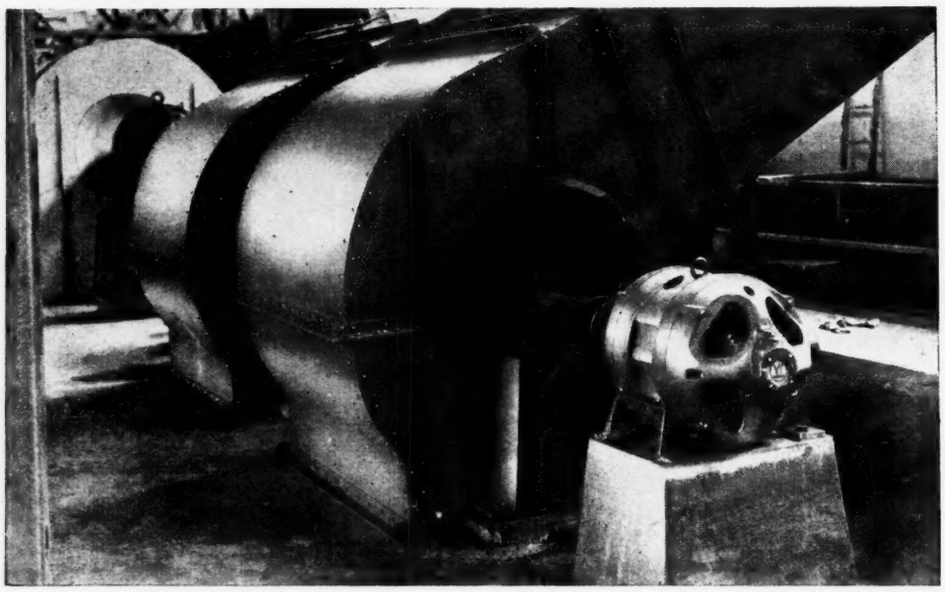
With the large generator operating no trouble was experienced with the voltage, but when the load was put on the two small machines it was impossible to maintain normal voltage. A particularly objectionable feature of this was that the magnetic switches or some of the controllers released to a point where they vibrated and caused arcing at the contacts.

Various methods of overcoming the low-voltage trouble were considered, such as an auto-transformer to step the voltage up. It finally was concluded that the only way to cure the trouble was to improve the power factor. Therefore, the 75-hp. motor on the motor-generator set was replaced by a synchronous motor to operate at leading power factor. The resulting power factor was 0.85 to 0.90 lagging, the load of the plant was reduced from 750 to 650 amp., and the switchboard voltage could easily be maintained at 240 volts. The two small generators will now carry the load satisfactorily. Sufficient power-factor correction is available in the synchronous motor to take care of any reasonable future expansion of the load.

An Economical Rust Remover

AN ECONOMICAL rust remover may be made easily of ingredients to be found in any drug store. The composition is: 3 oz. petrolatum, 2 oz. P.907 oil, and 6 oz. tripoli.

The oil and petroleum are steamed together until they are warm. Then the tripoli is added and the mixture stirred until it is smooth. When spread on rusty tools or parts and rubbed off with a cloth, this mixture will remove the most stubborn coat of rust.—*American Machinist.*



Purchasing Fans on Specification

By CHARLES A. CARPENTER
Consulting Engineer
Pittsburgh, Pa.

THE user of fans should approach his problems logically, and inquiries should be complete. Since practically all fan problems involve some doubtful calculations, it is advisable to ask for guaranteed operating performance on static pressure, maximum and minimum; temperature, maximum and minimum; speed, maximum and minimum; corresponding static efficiency; corresponding brake horsepower; maximum capacity; normal capacity; and partial operating requirements if conditions vary.

The barometer, relative humidity and (if gases other than air are to be handled) the specific weights should be given. Specific weights should be referred to some definite standard so that proper corrections of fan performance may be made. In general, the most important thing to give the fan manufacturer is sufficient information to indicate clearly the probable variation in operating conditions.

If convenient, a fan's speed or speeds should be left to the manufacturer. Speed affects fan performance much more than most engineers realize. The customer should clearly state if some fixed speed is necessary or simply desired. The range of speed permitted or set by local conditions should be specified.

Many fans are specified for large volumes at low pressure for direct connection to motors operating at speeds much too high for good fan efficiency. Occasionally the reverse is true; for example, specifying low speeds for high-pressure blowers. The importance of a proper speed for a fan should be recognized much more fully than is often the case.

This immediately brings to mind fan drives. The buyer should be specific, so that the fan manufacturer obtains a clear picture of the electric current available, the steam conditions or the horsepower furnished by line shafting, etc. Fans may be driven by motors, turbines, and engines, or from line shafting. They may be overhung on the shafts of the drivers, directly connected by suitable couplings, or indirectly driven. The method of drive desired should be stated in all inquiries, with possible optional arrangements. The option may permit a bidder to offer a much better proposition.

A consideration of the duty imposed is helpful if real engineering is to be applied to proper fan selection. A description of the purposes for which the fan is to be purchased should appear in inquiries. It is also well to give a sketch showing the fan, its drive and flue connections, so that the customer may receive expert advice on some of the surroundings that influence fan operations.

For large jobs involving big annual expense for power or steam, it is advisable to take the fan bidder into confidence on economics. It must always be kept in mind that present-day fans are not efficient for all conceivable conditions of service. In fact, the performance field covered by all fans now being marketed is relatively small; consequently, most large jobs involve a compromise between limitations of fans and limitations of drives. Useless expense may be incurred unless a thorough study of operating costs and fixed charges be made.

The type of fan and its construction influence its price. Forward-curved blading permits of the use of a smaller fan than backward curvature. Consequently the

forward-curved fans are cheaper, but they are less efficient than well-designed backward-curved fans. Actual operating requirements may virtually fix the type. At any rate, a proper inquiry should request performance curves, so that the question of type will be brought out by the bidding. There are many controversial features in fan construction. Some manufacturers stress construction details to emphasize a particular design. However, certain items of material and workmanship should be specified.

A fan shaft should be amply strong for torsion and bending at maximum load and maximum temperatures. It should be stiff enough to keep the critical speed well above any operating speed. The bearings should be liberal in carrying capacity; arranged to permit of easy alignment; equipped for suitable lubrication; water-cooled, if necessary; and accessible for repair or renewal. Many good bearings are available; they may be of the ball, roller or sleeve type. Bearing pedestals should be as short as possible, to prevent lack of rigidity. They should be well constructed, with wide support at the base to stop any tendency to rock.

The fan wheel should be well supported on the shaft, and some attention should be paid to details such as keys and keyways. It must be remembered that a fan wheel may have considerable weight and may run at relatively high speed. Steps should be taken in design and construction to prevent distorting the rotating parts out of alignment and out of balance. It is evident that the rotating parts should be statically and dynamically balanced. Vibration hastens repairs and is the cause of a large part of the complaints arising from fan service.

When buying a watch you purchase something to keep time, not so much gold or so many little cogwheels. How do you know it keeps correct time? By comparing it with standard timepieces in which you have confidence. The purpose of this article is to help engineers to compare their fans with a set of standards

The construction of the wheel increases in importance with severity of duty. High temperatures, abrasive dust and high tip speed require special attention. Inquiries should take into consideration the thickness of steel plates, analysis of steel if for very severe service, and details of bracing, so that a fair comparison may be made of bids received.

The casing or scroll must be arranged to suit each job. Direction of discharge, type of inlet (single or double), position of drive, and general adaptation to ducts and other equipment must be kept in mind when designing a fan. The casing design is of importance, since it greatly affects efficiency. Many well-built fans are spoiled by poorly designed scrolls. In any general specification it is well to call for definite thicknesses of casing sheets or plates and for definite sizes of bracing angles.

Fan bedplates often represent a waste of money. The type of bedplate is largely a matter of personal choice or prejudice. Any piece of machinery of considerable weight rotating at high speeds must be kept lined up. No bedplate within reason is a substitute for careful setting up and no bedplate of ordinary proportions will overcome the shortcomings of poor foundations. The important thing to start with is a good solid, permanent foundation. The second item is to have bearing pedestals rigidly supported. With proper bearings and balanced equipment these steps insure proper operation of the rotating elements. The casing, of course, should be well supported, due allowance being made for possible loads due to connected flues and stacks.

Summarizing, a good fan specification should include a statement as to type of fan wheel, and give considerable attention to construction. Basic comparisons of bids must be by type and construction.

Having reached the point of receiving bids, a prospective buyer faces a rather difficult decision. Assuming that he buys from a responsible company of good reputation, he can readily enforce his specifications as to type of wheel blading, details of construction, balance, arrangement, and accessory equipment. These features are obvious. The doubtful elements are: Does the fan meet the service conditions?; is it meeting the efficiency guarantees?

Most fan engineers have found by testing that fan characteristic curves group themselves by types of design regardless of who makes them. Assuming that characteristic curves of competitive bidders have been investigated for conformity to type, it is important to find out upon what basis these curves were computed. Have exactly similar fans been tested? Were these tests made in the field or laboratory? Were all corrections made for relative density? How many tests were made? Did different men make them? In other words, no characteristic curve submitted with a proposal is worth the paper it is drawn on unless a definitely sound test background is behind the basic engineering data.

Guarantees may be approached in similar manner. A guarantee is only worth the integrity, financial responsibility, and knowledge of the guarantor.

In order that an industry may progress, new ideas must be exploited. It is worth while to consider improved equipment provided that the seller has a background making it reasonable to suppose that the new product is sound.

Assuming that the fan has been purchased, can it be tested within reasonable accuracy? The writer believes that fans sold by thoroughly reliable manufacturers in accordance with characteristic curves true to type and definitely based on a number of accurate laboratory tests of exactly similar fans need no field tests unless some condition arises making it appear that the fan is not meeting guarantees. This statement is made because field tests introduce inaccuracies that are much greater than engineering calculations based on the theory of similitude of design.

However, many fans are sold with no such reliable background. In fairness to both buyer and seller, fans with doubtful guarantees should be tested, preferably under laboratory conditions if possible. Should the duct arrangement of the installed job lend itself to a fair

test, a field check of operations is the more desirable, because it simultaneously shows what the fan is actually doing on the job and how well it is doing it. Such a test determines whether or not the estimated performance requirements were correct. Many fans are inefficient in service because the job requirements do not suit the type that has been installed.

The speed can generally be determined accurately, but it rarely stays constant throughout a test. Corrections of readings must, therefore, be made to bring all data for any one test to some definite constant speed. Power determinations are difficult to get in the field. Direct-connected motor drives are possibly simpler for accurate evalution than the steam turbine or indirect drives.

Static pressure measured by a water gage can be read fairly accurately unless the velocity of flow past the tube be sufficient to affect the water level. Readings should be taken at various positions in the flue at the point of test to bring out irregularities of pressure. Total pressure and velocity pressure require careful test work. A fan should be supervised by an engineer familiar with the work, and attention should be paid to details such as temperature, barometer, density of gases other than air, duct layout, flow turbulence and other conditions.

There is a standard fan test code in use by the Society of Heating & Ventilating Engineers and the Fan Manufacturers' Association. Engineers testing fans should familiarize themselves with this code.

Finally, it is well to check fan performance from time to time, particularly if flues have been altered or operating conditions changed. Many fans waste more money in excess power cost every year than their first cost. Such fans should be replaced with equipment that better fits the conditions.

▼ ▼ ▼

New England to Have a Floating Power House

NEW ENGLAND is to have a new kind of power plant—a floating station that can be towed to whatever section of the territory is in need of additional power. A large part of the energy required by the subsidiaries of the New England Public Service Company is supplied by water power; but it is necessary to have a certain amount of steam auxiliary. To meet this need the utility has purchased the S. S. Jacona, a 7,000-ton cargo vessel, from the United States Shipping Board, and is transforming it into a generating station.

Two turbine-generators, each rated 10,000 kw. and operating at 3,600 r.p.m., are being installed on the ship. The turbines will operate on steam at 400 lb. pressure and 250 deg. superheat, and exhaust into condensers at 1 in. mercury back pressure. Steam consumption will be between 9 and 10 lb. per kilowatt-hour. The turbines will drive direct-connected 10,000-kw. generators, which will employ the closed system of ventilation with surface air coolers, through which sea water will be circulated. Four marine-type boilers, capable of furnishing 240,000 lb. of steam per hour at 425 lb. and 250 deg. will be oil-fired, each furnace being equipped with eleven burners of the Cuyama design. Furnace walls will be of firebrick and special insulation. Each boiler will be equipped with air preheaters. The boiler plant is planned to operate at 83 per cent efficiency. Two boilers are to be equipped with re-superheaters to provide steam for heating fuel oil and for miscellaneous purposes. All boilers, superheaters, and air heaters are to be equipped with soot blowers. Both forced- and induced-draft fans will be used, and two boilers will be connected to a short steel stack.

The center of the vessel is occupied by steel tanks. One will be used as a water tank, the other as a surge tank, holding a supply of hot water in emergency for boiler-feed purposes. Make-up water will be supplied by a shore connection, and will be passed through evaporators for purification. All water for boiler feed will go through feed-water heaters for temperature control, and be deaërated.

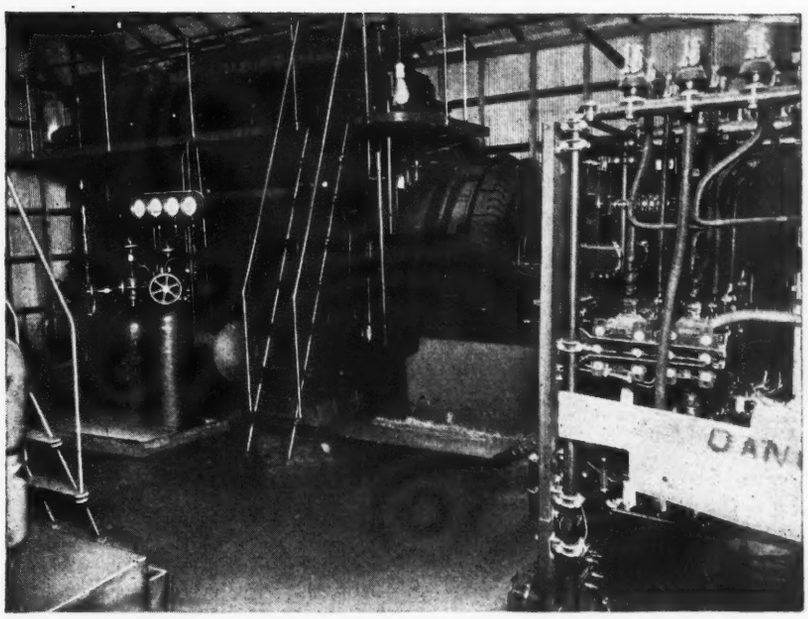
The boiler plant will be forward, and room will be left for possible future coal-crushing equipment. Turbine equipment will be aft, and the switchboard will occupy the intermediate deck toward the stern.

By installing the generating equipment on shipboard, additional reserve capacity has been made available at any one of several points along the New England coasts, and approximately twice as many hours of use of the investment can be secured in a term of years when compared with a stationary generating plant. As fixed charges are an important part of the cost of energy from a stand-by plant, this increase in the number of hours of operation should reduce the kilowatt-hour cost.

A new kind of generating station, a floating power plant that can be towed from place to place to meet the demands of different sections for added power

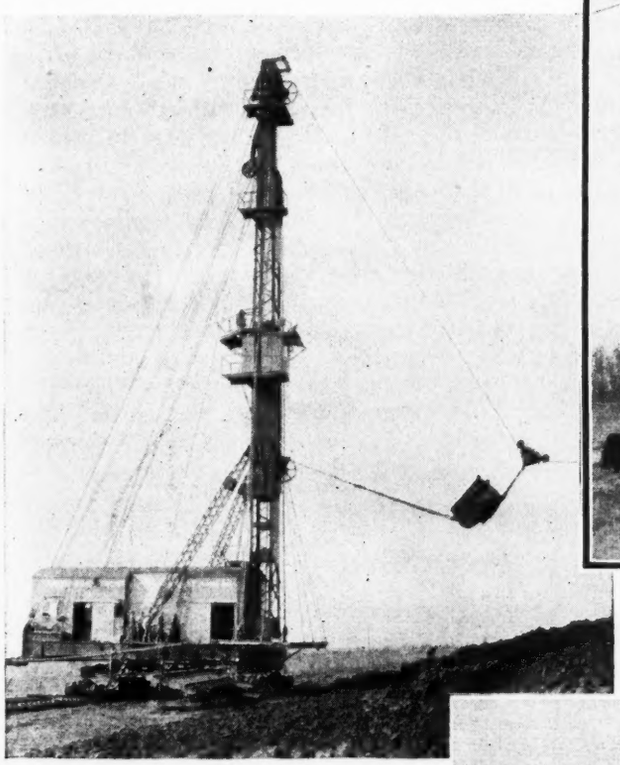
A Mississippi Levee Power Plant

IN building 2,400,000 cu.yd. of Mississippi levee near New Madrid, Mo., Clark Brothers Construction Company is using an electrical tower excavator which moves along the levee as work proceeds. Power is obtained from two 400-hp. Diesels, one being shown at the right.

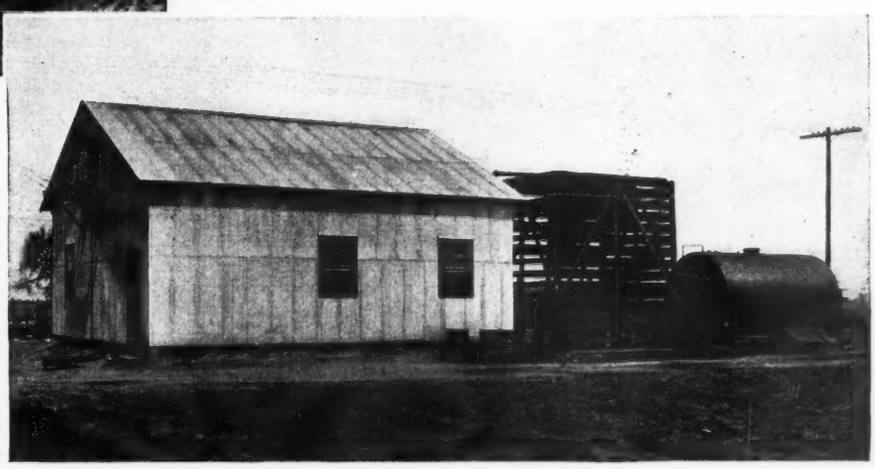


▼

The tail tower is on a caterpillar body which is moved along the ditch by a motor



Above—The head tower is mounted in a caterpillar chassis which carries the Ward-Leonard motor drive and the hoists



Right — This building houses the two Busch-Sulzer Diesels supplying power to the excavator

OPERATING FACTS

from MAD RIVER . . . *A Two-Year Résumé of Pr*

Modern stokers, combination superheaters, economizers, air heaters, and three-stage bleeding contribute to over-all average boiler economy of 86.3 per cent. With period load factor of 42.6 per cent station, economy has averaged 15,923 B.t.u. per kilowatt-hour delivered

DURING the summer o 1927 the first 20,000-kw. unit in the Mad River plant of the Ohio Edison Company, Springfield, Ohio, went into operation. This plant was projected for an ultimate capacity of 80,000 kw., but with a reliable reserve in the 24,500-kw. Rockway plant of the company, the expectation was to carry on with the first unit in the new plant for a considerable period and for the first two or three years on a comparatively poor load factor. Almost three years have passed, and, considering the conditions, remarkably good economy has been obtained. A summary of the records for the years 1928 and 1929 are given in the tables.

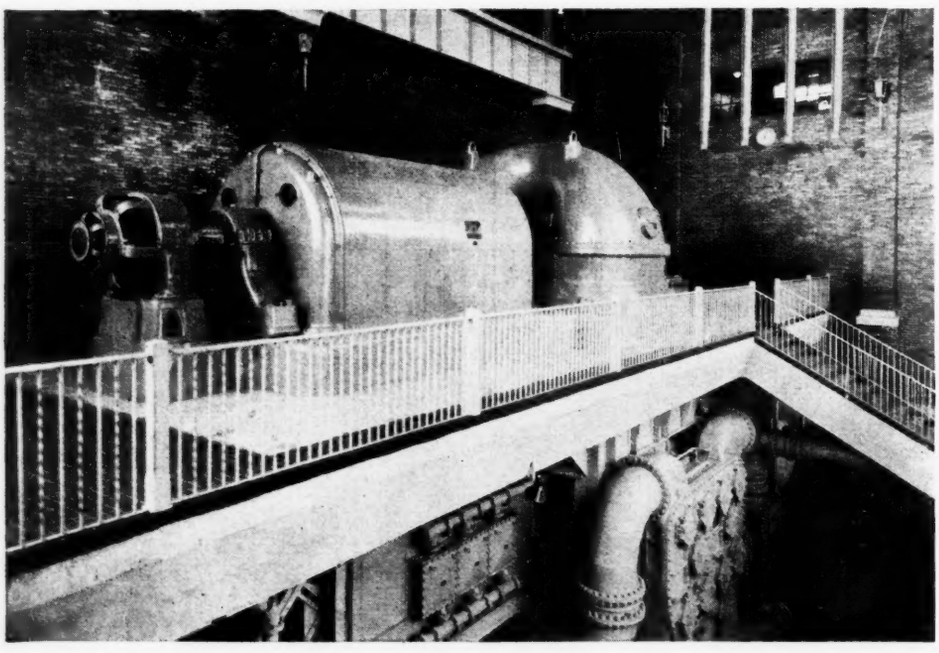
For full details on the plant, reference may be made to the Sept. 20, 1927, issue of *Power*. The compact layout is shown in the accompanying sectional elevation. Briefly, the prime mover is a 14-stage, 20,000-kw. turbine arranged for bleeding from the fourth, eighth and eleventh stages to heat the feed water. A surface condenser of the two-pass, divided-water-box type is served by circulating and condensate pumps in duplicate and a twin two-stage ejector with inter- and after-condenser for air removal. The generator is a 12,500-volt, 60-cycle, three-phase machine with main and pilot exciters on the same shaft. A closed system supplies clear air for cooling.

Two boilers of the sectional-header, cross-drum type, with 12,757 sq.ft. of surface each, supply steam to the turbine at 400 lb. pressure and a final temperature of 690 deg. F. Stokers are of the underfeed type, 14 retorts wide and 29 tuyères long, driven by variable-speed motors. The rear and side walls of each furnace are water-cooled by 658 sq.ft. of surface in armored tubes.

Radiant elements of the combination superheaters occupy part of the side walls. Waste heat in the flue gases is absorbed by comparatively small steel-tube economizers and plate-type air heaters having over 10 per cent more surface than the boilers. The combustion air is preheated to about 250 deg. F.

Three-stage bleeding raises the temperature of the feed water 105 deg., so that from the economizers the water enters the boilers at about 270 deg. F. Make-up is provided by an evaporator.

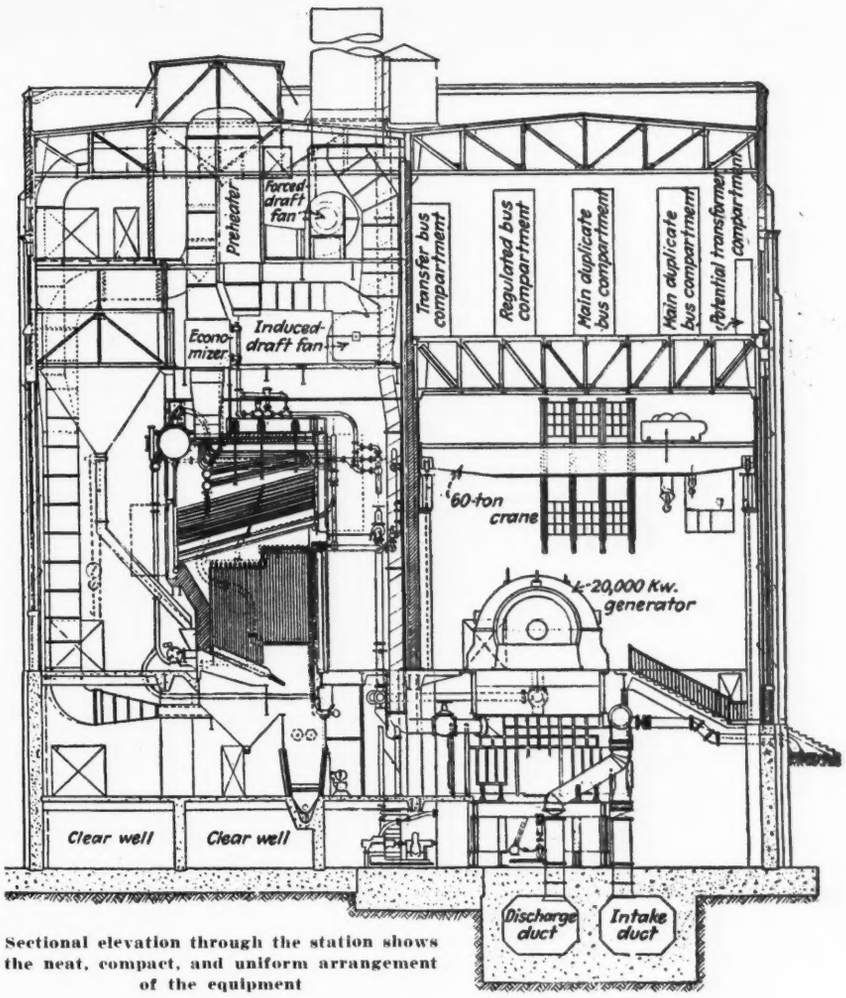
Table I gives a summary of results for two years. It will be seen that economy improved in 1929, owing principally to the greater load, more experienced operators,



Turbine availability records for 1929 show that the machine was in operation 98.62 per cent of the time. For 0.175 per cent of the time it was off from turbine trouble, and 1.205 per cent of the outage resulted from other causes.

...é of Practical Experience

By JOHN W. MIKELS
Chief Engineer, Mad River Station



Sectional elevation through the station shows the neat, compact, and uniform arrangement of the equipment

slightly better coal, and a reduction in the number of shutdowns. With a period load factor of 42.6 per cent, the average production of a delivered kilowatt-hour on 15,923 B.t.u. may be considered excellent performance, requiring as it does 1.28 lb. of 12,440-B.t.u. coal. During the year the peak load was 21,000 kw., and the average load 8,990 kilowatts. The boilers steamed at an average rating of 131 per cent. Flue-gas temperature at the economizer inlet averaged 599 deg. F., and at the air heater outlet 268 deg. The air was preheated to 243 deg. F. An over-all boiler economy of 86.3 per cent is indicated. The coal was of fairly good quality, with volatile content running about 35 per cent, and the ash 10 per cent. A 15,000-kva. transmission tie made recently with Dayton and other connections to be made later are expected to improve the load conditions and, as a result, the sustained economy for 1930.

While Table II gives the details of operating expense in percentages, it is of interest as the relation of one item to the others is shown. Fuel is naturally the largest item, averaging in 1929 nearly 69 per cent of the total. Labor comes next, with a percentage of 15.77, covering the services of 29 men, six engineers, six firemen, one utility man, three pump attendants, two coal handlers, three switchboard operators, six maintenance men, and two clerks. Superintendence amounts to about one-fifth of the labor charge. Water, lubrication, production supplies, station expense, and building maintenance are relatively small items. General equipment maintenance exceeds 8 per cent. Boilers, stokers, and steam accessories are accountable for three-fourths of this amount, and the turbine and auxiliaries for a little less than one-fifth.

EQUIPMENT MAINTENANCE AND AVAILABILITY IN 1929

BOILERS—*Two, cross-drum, 12,757 sq.ft. each, 450 lb.:*

Each boiler is inspected internally four times per year. No deposits of scale or corrosion have been noticed. There have been no tube replacements or leaks around rolls. The availability records in Table III cover the time the boiler is off the line until it is back on. They include time taken out for inspections, stoker repair, etc., as the repairs on the stokers are made at the same time. One boiler is capable of carrying the full plant load over the week-ends, when the boilers are taken out of service. During boiler inspections and repairs the Rockaway plant is used for stand-by protection.

No troubles have occurred either with the combination superheater or the saturated pop valves. During 1929 the "A" soot blower elements and bearings were replaced in both boilers at a cost of about $575. It has been found necessary to keep these elements in good operating condition to prevent slag accumulation on the boiler tubes. Owing to the throttling service, the 2½-in. steel soot blower header valves gave considerable trouble, which should be relieved when cone seats and disks are installed.

FURNACES—*Side and rear walls water cooled with 658 sq.ft. of armored tubes:*

The furnaces are in good repair. Some erosion has occurred on the front walls and there are some cracks in them. Below the radiant superheaters and above the side observation doors minor brickwork repairs were made. About 500 firebrick and 50 firebrick slabs were used during the year 1929. Some erosion and burning away of the cast-iron blocks surrounding the water-wall tubes have occurred, but no tube replacements have been necessary. No scale or deposits exist in the tubes.

STOKERS—*14 retorts, 29 tuyères, 352.7 sq.ft. projected grate area:*

The great majority of replacement parts consisted of extension grates, center tuyères and coal plate extension

noses, center tuyères, connecting rods and caps, grate shaft brackets, and middle and bottom section air backs. Cast-iron connecting rods are being replaced with steel when they break. A tabulated list of stoker maintenance costs for 1929 and the comparative costs for 1928 appear in Table IV.

Appreciable reduction in stoker maintenance during 1929 was made possible by the use of steel arms in the renewal of faulty grinder-arm supports. Grinder-arm breakage was a large item of cost during 1928.

Repacking of the stoker wind boxes in 1928 also caused considerable labor charge. As operation proceeded the men became better trained in firing stokers. They carried the ashes deeper over the rear end. Tightening of the dampers on the rear compartment wind box resulted in fewer extension grate renewals. The pusher and extension grate rods were readjusted, with resulting improvement. The maintenance crew had more experience about the necessity of renewing parts. In all stoker maintenance work it is a problem to determine how much longer a damaged casting would have lasted if it had remained in the stoker. Experience has bettered this judgment. Lower maintenance costs are expected in 1930.

PIPING:

Some trouble was experienced from header gasket failures. Metallic gaskets have been purchased for renewal of the sheet gaskets when failure occurs. In the $\frac{3}{4}$-, 1-, and $2\frac{1}{2}$-in. steel valves considerable trouble was encountered from the wear of the flat-type seats and disks. Replacement of all flat seats and disks by the cone type made of stainless steel is being considered for all throttling service.

ECONOMIZERS—*Steel tube, 4,608 sq.ft. of surface:*

Tubes in the economizers are of steel No. 9 gage, 2 in. outside diameter. On the outside is fitted a series of gill-shaped rings. Each unit is 8 rows high and 12 rows wide, with elements 16 ft. long over the rings. Inspection every three months has shown slight internal corrosion, but no corrosion on the outside of the tubes or around the rolled joints. There have been no deposits of scale.

AIR HEATERS—*Plate type, $\frac{3}{4}$-in. air and 1-in. gas spacing; surface 14,220 sq.ft.:*

Dirty air heaters have offered a serious difficulty. Because washing the gas side of the plates has not proved successful, mechanical cleaners are to be installed. The heater elements are in good condition. From observation, an estimate of the life of the heaters is from five to eight years.

PUMPS:

No troubles have occurred with the duplicate circulating pumps. Of the three 500-gal. per minute boiler-feed pumps, two are motor driven and one is steam driven. Any one of the boiler-feed pumps will carry the full plant load. Each pump is inspected internally twice a year. No serious troubles have existed, although attention has been given to adjustments, clearances, and minor repairs. Oil deflectors were put on the outboard bearings of the motor-driven pumps and water deflectors on the inboard bearings to prevent water's blowing into the bearing oil from the pump glands.

The duplicate motor-driven condensate pumps gave considerable trouble during the start up of the plant, owing to impeller cavitation and erosion. Impellers would last approximately twelve weeks. A liquid level controller installed on the hot well has prevented further trouble. The shaft and impeller assembly was redesigned to prevent oxygen contamination of the condensate.

The house-service, sump, and ash-sluice water pumps have given no trouble.

EVAPORATOR—*Coil-type, 11,000 lb. per hour:*

Considerable trouble was experienced during the year from scale accumulations on the steam coils. In September, 1929, the scale was removed with a chemical compound and by boiling out the evaporator. The scale deposits should crack off better when higher pressure is available for cracking steam from the fourth stage. No coil replacements have been necessary.

HEATERS—*Closed, 220,000 lb. per hour:*

No trouble has been experienced on the two closed, stage feed-water heaters. The domestic heater was in bad condition from internal oxygen corrosion, so it was painted internally with a protective coating in the latter part of 1929. An annual painting will be necessary.

FANS—*Forced-draft, 70,000 cu.ft. per min., 9.8 in. s.p.; drive, two constant-speed motors, 75 and 150 hp.—Induced draft, 120,000 cu.ft. per min., 8 in. s.p.; drive, two constant-speed motors, 100 and 250 hp.:*

Both the forced- and induced-draft fans were examined periodically and found to be in excellent condition. The blades showed no wear. The induced-draft fans became unbalanced a few times because of dirt coming over from the preheaters when they were washed. Washing

TABLE I—OPERATING RESULTS FROM MAD RIVER STATION

Year	1929	1928
Generation, kw.-hr.	78,730,850	67,860,500
Station output, kw.-hr.	74,252,170	63,639,920
Average load, kw.	8,990	7,730
Peak load, kw.	21,000	19,500
Period load factor, per cent	42.6	39.65
Coal per kw.-hr. del'd., lb.	1.28	1.33
Coal as rec'd., B.t.u., per lb.	12,440	12,209
Ash content, per cent	9.94	10.16
B.t.u. per kw.-hr. del'd	15,923	16,238
Water rate, lb. per kw.-hr. del'd	11.45	11.67
Average boiler rating, per cent	131	127
Flue-gas temp. econ. inlet, deg. F.	599	592
Flue-gas temp., air heater outlet, deg. F.	268	262
Air temp., outlet of air heater, deg. F.	243	256
Boiler eff., including econ. and air heater, per cent	86.3	85.8

TABLE II—OPERATING EXPENSES IN PER CENT

Year	1929	1928
Superintendence	3.345	3.853
Labor	15.774	15.433
Fuel	68.687	67.622
Water	0.138	0.145
Lubricants	0.265	0.153
Supplies	0.389	0.428
Station expense	1.451	1.680
Building maintenance	1.710	1.753
Equipment maintenance	8.241	9.933
Total	100	100

TABLE III—BOILER AVAILABILITY RECORDS

Boiler	Year	Times Out of Service	Hours Out of Service	Decrease in Outage Hours	Per Cent Available Hours in Service
1	1929	16	1,230	449	85.97
1	1928	26	1,679	...	80.90
2	1929	19	1,196	443	86.35
2	1928	27	1,639	...	81.30

TABLE IV—STOKER MAINTENANCE COSTS

Stoker	Year	Tons of Coal	Labor in Dollars	Castings in Dollars	Labor, Cents per Ton	Castings, Cents per Ton	Total, Cents per Ton	Cents per Ton of Total Coal	Decrease, Cents per Ton
1	1929	23,059	395.70	1097.15	1.72	4.76	6.48	.....	5.87
2	1929	24,408	263.50	1059.57	1.08	4.34	5.42	5.94	
1	1928	21,937	921.30	1986.21	4.20	9.05	13.25	.....	.....
2	1928	21,533	784.80	1438.19	3.64	6.68	10.32	11.81	.....

of the preheaters has been discontinued. Coupling bushings were renewed on both sets of fans. The packing in the glands around the shaft on the induced-draft fans was renewed. The fans have been available at all times.

ASH-HANDLING APPARATUS—*Sluicing system, one 1,000-gal. per min. sluicing pump and two 1,000-gal. per min. ash pumps:*

The ash-sluicing system has given no particular operating difficulties. The sluiceway was relined with cast-iron liners in the early part of 1929. Previously the lining had been cement with steel rod. No expense has been encountered with the ash dump plates. Water nozzles had to be cleaned a few times, and the direction of water flow from them had to be adjusted. The ash pumps conveying the ashes from the building have required a few repairs. The manganese steel lining and the impellers have needed renewing. The 300 ft. of cast-iron pipe carrying the ashes from the pumps to the point of disposal will be renewed during 1930, after about three years of service.

In the coal-handling equipment only minor repairs have been made.

MAIN TURBINE—*20,000 kw., 14-stage, 1,800 r.p.m.:*

The main unit has operated well for nearly three years. No thorough inspection of the high-pressure end has been made, but the exhaust hood will be lifted this year for the purpose of a complete mechanical inspection of the spindle. The thrust and all main bearings were inspected in 1928. Inspections of the atmospheric relief valve and the last few rows of blading have been made at every opportunity. No serious seal troubles have existed. It is believed there is some excess clearance at the present time on the high-pressure end. Packing on both the upper and lower glands was renewed, and the control valves were repacked. New rings were required on the throttle trip cylinder.

Turbine availability records for 1929 show that the machine was in operation 98.62 per cent of the time. For 0.175 per cent of the time the machine was off from turbine trouble, and 1.205 per cent of the time from other causes. In 1928 the machine had an availability record of 96 per cent. A complete list of turbine shutdowns and their causes is given in Table V.

It will be seen that the number of total interruptions is considerably less than in 1928. Several major items of repair work were completed during the earlier year, such as repacking the main condenser, replacing the boiler feed-pump check valves, installing a liquid level controller on the hot well, inspection of all bearings on the turbine and cleaning the intake pressure tunnel twice. The pressure tunnel was cleaned but once in 1929.

TABLE V—TOTAL TURBINE INTERRUPTIONS IN 1929 AND THE CAUSES

Date	Time Off Hr.	Min.
Jan. 12—Inspected and cleaned air ejectors and condenser	15	9
Feb. 3—Packed control valve	5	54
Mar. 17—Renewed exciter brushes	4	40
Mar. 23—Cleaned intake tunnel	34	45
May 5—Renewed exciter brushes	3	29
June 29—Cleaned station power structure, renewed exciter brushes, and inspected switches	16	5
Aug. 18—Renewed pilot exciter brushes	0	22
Oct. 8—Renewed gasket on main steam header	6	32
Nov. 11—Cut over to Dayton bus structure	24	25
Dec. 22—Packed throttle and control valves	9	31
Total 1929	120	52
Total 1928	357	53
Decrease, 1929	237	1

CONDENSER—*Two-pass divided water box, 27,000 sq.ft., 1 in. O. D. Muntz metal tubes:*

No unusual trouble was encountered with the main surface condenser. The tubes are packed on the ferruled ends with a fiber washer next to the ferrule. To date there has been no tube trouble or tube replacement. With the divided water box it is possible to clean one-half the surface while under operation. In the inter- and after-condenser operating in connection with the air ejector equipment some tubes were found to be plugged after they had been in service for over a year, probably a result of carelessness during construction. No tube troubles have been experienced.

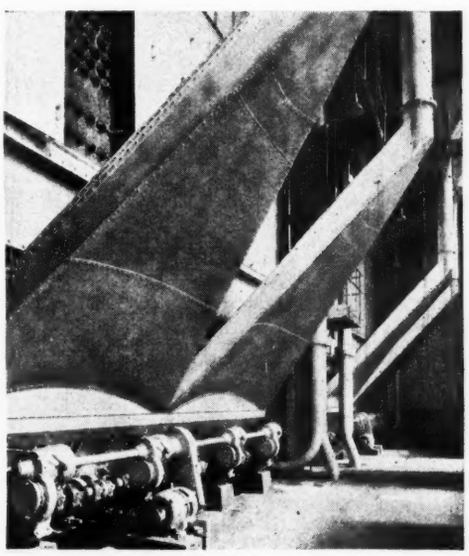
PRESSURE TUNNEL:

Circulating water is supplied to the condenser through a pressure tunnel, which has worked well with the exception that it tends to fill with small débris and gravel that comes in past the screen. The accumulation must be removed about once a year. Previous to 1929 we had considerable trouble with the screen and tunnel when leaves were coming down the river. To relieve it a wing wall was arranged in front of the trash rack on the intake. A $\frac{3}{8}$-cu.yd. grab-bucket hoist is used to keep the channel clean.

Several sprockets in the driving gear of the traveling screen were broken before the trouble was cleared up by equipping the drive with a shearing pin. Washed-in gravel became lodged between the boot and the baskets, causing an overload on the sprockets. The pins, bushings, and a few rollers are renewed every fall. Some baskets, wires, and links also have been renewed.

ELECTRICAL MAINTENANCE:

In the control and metering circuits several fuses and resistance carbons were blown on the transmission and feeder circuits. Several grounds occurred on the control circuits. The alarm on the circulating pumps was revamped. The bars of the vacuum cleaner motor became loose in the rotor. The ashpit sump motor was rewound twice. The armature on the motor of the forced-draft damper control was rewound. During the year all motors were meggered. Oil circuit breakers were inspected periodically. The oil was tested. Main contacts were found to be in good shape. Some arcing tips were blistered. There was practically no trouble with the main turbine-generator. The field collector rings were ground, and a new grade of exciter brushes was adopted.



Appreciable reduction in stoker maintenance during 1929 was made possible by the use of steel arms when renewing faulty grinder-arm supports

Waste Heat Boilers For Diesel Engines

IN MOST localities, and under the majority of operating conditions, there is a heating requirement wherever there is a power plant. If Diesel engines are installed some steam can be obtained from the exhaust gas through the addition of a waste-heat boiler.

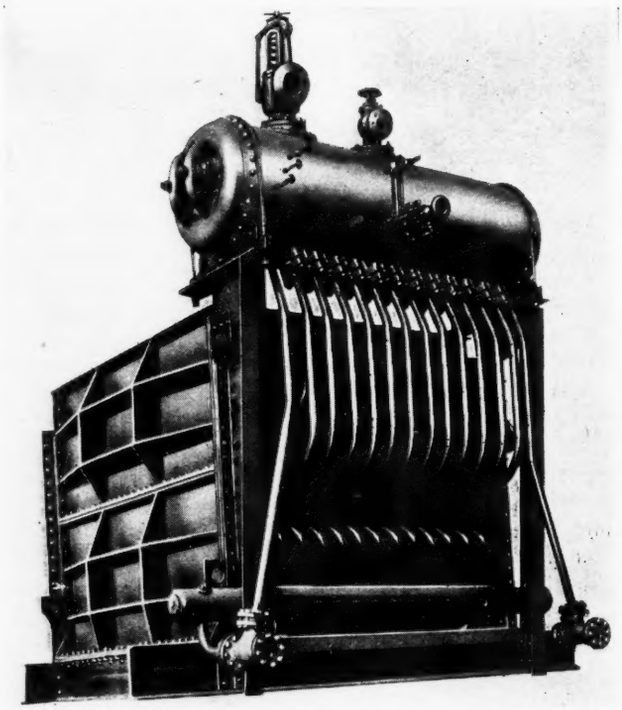
Several modifications and new designs of waste-heat boilers have appeared, and experience has pointed out the characteristics which a waste-heat boiler must have in order to be satisfactory. The unit must be capable of recovering heat efficiently from low-temperature gases, and, if desirable, be built to permit of direct firing when the main engine is shut down. It should be so constructed that it will not be damaged by operation of the Diesel engine when the boiler is dry.

To meet these requirements the Foster Wheeler Corporation has brought out the water-tube waste-heat boiler shown in the illustrations. Feed water enters the upper rows of tubes, known as the economizer section, where the relatively cool water reduces the exhaust gases to a minimum temperature. Water from the economizer enters the steam drum and flows down to a header connected to the lowest row of heating tubes.

The water circulation is then back and forth through the heating tubes, and upward to the steam drum, there being one drum connection for each vertical row of heating elements. This arrangement is necessary since no rear water leg is used. Instead, there are orifice plates in each downcomer pipe, proportioned to restrict the flow of water and prevent reversal of direction.

The elements consist of 2-in. seamless steel tubes covered with cast-iron, extended-surface rings reamed to size, heated, and shrunk on.

Element tubes are passed through a tube sheet at the steam drum, or front end, and are rolled directly into the sheet. Then the connecting flanges are placed on the ends of the tubes, but the tubes are fastened at one place only. The return-bend ends of the tubes are supported in plates and are free to move back and forth in the plates. This eliminates any stress at the flanged connections. The return bends are packed in insulation and housed in a tight steel box. The casing is air-tight.

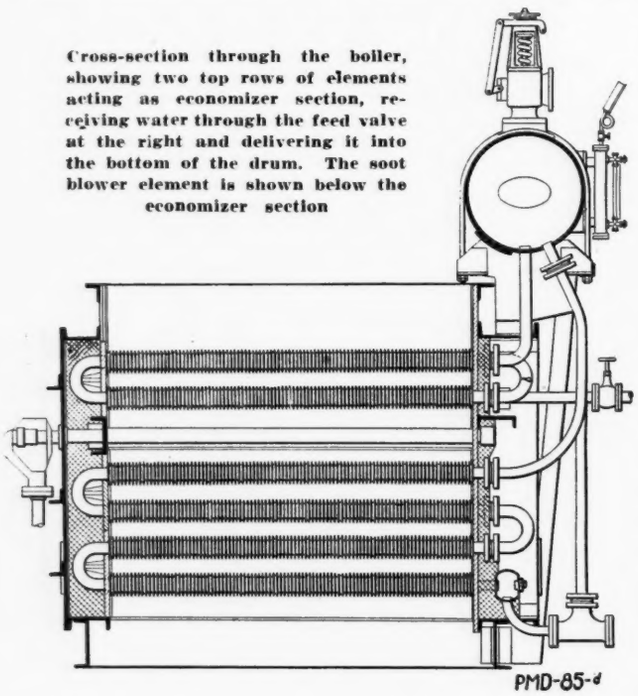


Assembly view of the Foster Wheeler waste-heat boiler

The boiler may be mounted over a small combustion chamber, fitted with independent oil burner for heating the boiler when the engine is shut down.

The following figures were obtained under test at the Hooven, Owens & Rentschler plant with a boiler connected to a M.A.N. type, two-cycle, double-acting, four-cylinder, air-injection Diesel:

Steam pressure, lb. per sq.in. gage	43.5
Back pressure on engine exhaust, in. of water	6.0
Temperature gases entering the boiler, deg. F.	538
Temperature of gases leaving boiler, deg. F.	346
Water temperature entering boiler economizer, deg. F.	168
Indicated horsepower	4,812
Brake-horsepower of engine	4,019.5
Fuel consumption, lb. per hr.	1,669.5
Fuel consumption, lb. i.hp.-hr.	0.346
Fuel consumption, lb. b.hp.-hr.	0.438
Engine speed, r.p.m.	110
Water fed to boiler, lb. per hr.	2,820
Exhaust gases lb. per hr.	85,000
Thermal value of fuel, B.t.u. per lb.	19,000



Cross-section through the boiler, showing two top rows of elements acting as economizer section, receiving water through the feed valve at the right and delivering it into the bottom of the drum. The soot blower element is shown below the economizer section

Germany's Power Output Increases

AN INCREASE of over 10 per cent in electric power production in Germany is revealed by figures just issued for the year 1929. Electrical output rose last year to 30,700,000,000 kw.hr., compared with 27,900,000,000 kw.hr. in 1928.

More than 10 per cent of the total electrical production is controlled by the German Government through its holding company, United Industrial Enterprises Company (Viag), which thus owns the largest electric power system in Europe. The United States has an annual output amounting to 41 per cent of the estimated world total of 300,000,000,000 kw.hr. annually, Germany ranking second with an output equal to 10 per cent of the total. Canada, Great Britain, and France occupy third, fourth, and fifth places, respectively.

. . . RIGHT OUT OF THE PLANT . . .

Water Back-Up Alarm for Condenser Well

OCCASIONALLY we have experienced trouble from condensate backing up into the condenser well. To overcome this trouble we removed a handhole plate from the well and mounted on it a small float as shown. Then we drilled the plate to take a sparkplug after extending and enlarging the conductor through the plug to make a contact on the other end of the rod. If the water level rises in the well, contact will be made on the end of rod through the plug.

To complete the circuit we purchased two small transformers of the bell-ringing type with a capacity of 100

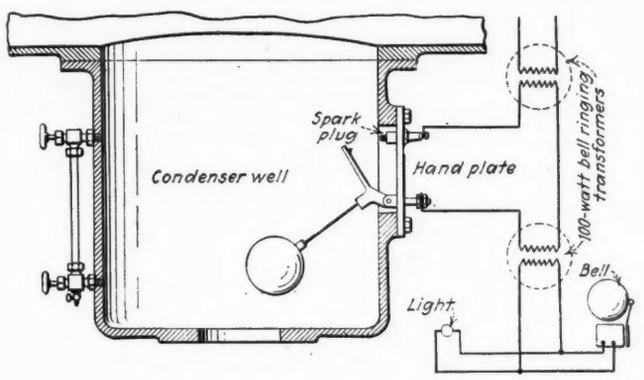


Diagram of condensate back-up alarm

watts or more and a ratio of 110 to about 20 volts. We connected the high side of one transformer to the lighting circuit, then connected the 20-volt side of the two transformers together; but looped the circuits through the contacts of the float, as shown on the illustration. The second transformer was used to step up to 110 volts so that a standard lamp could be used on the light signal, as well as a standard 110-volt alternating-current bell.

V. E. JOHNSON, *Supt. Steam Plants,*
Southern Sierras Power Company.
San Bernardino, Calif.

Benson Plus Loeffler?

THE RECENT revolutionary trend in steam pressures means more than just an increase in pressure; weighing 5.5 lb. per cubic foot, steam at 2,000 lb. per square inch is rather a liquid than a gas, and is one-seventh as heavy as boiler water, compared with 1/130th at 200 lb. per square inch. Basic fundamentals of the conventional type of boiler, the circulation and life of which are founded on the difference in weight of water and steam, are being upset. The use of hitherto unknown degrees of superheat becomes essential.

Many examples in the development of technical arts lead us to expect that these revolutionary changes in the qualities of our working medium will ultimately be accompanied by a revolution in steam generators.

The Loeffler boiler demands special attention in this light: It is not only fit for highest pressures, but it is fit exclusively for the highest ranges above 1,000 lb.; it would be an impossible proposition for 200 lb.

Loeffler substitutes forced circulation for the gravity circulation of the conventional boiler, and so becomes independent of the diminishing difference in specific weight of water and steam; he removes water-cooled surfaces from the boiler proper and takes up the furnace heat by rapidly circulating steam, thereby solving the scale problem; and he takes almost immediate control over the temperature of the generated steam by adjusting at will the speed of circulation. It is not necessary to leave a margin for occasional rises in temperature with load fluctuations, and it is possible to constantly produce any desired degree of superheat.

These three characteristics are based upon the use of a circulating pump which has to handle dry saturated high-pressure steam of about three times the useful output of the unit against a pressure difference of 20 to 60 lb. This pump is the heart of the Loeffler system.

Benson has forced circulation, too; but he retains the conventional water-cooled heating surfaces and enforces the flow by the feed pump. He has no free control over the cooling effect, as the latter is dependent on the feed supply, and there is no definite control of the superheat, just as in the ordinary boiler. He further has no buffering capacity. On the other hand, Benson requires no special steam pump.

Wilhelm Firing's interesting proposal (*Power*, April 15) would eliminate Professor Loeffler's mechanical circulating pump, while retaining all the ideal characteristics of the Loeffler principle, which include high pressure buffering against load fluctuations. It constitutes, in fact, a Loeffler boiler in which the mechanical pump has been replaced by a jet pump, fed from a Benson system which forms part of the generating installation and gets only pure feed water. A certain quantity of steam, about one-third of the useful output, but controllable to a certain degree, is generated in the Benson part at a pressure sufficiently above that of the Loeffler section to furnish the required energy for circulation.

Mr. Firing's combination is entirely workable; it introduces no new characteristics of the generating system, and it is therefore purely an economic and operating question whether the Loeffler pump or the Benson substitute should be preferred to maintain circulation.

The problem consists in transmitting to the circulating steam of the Loeffler system the energy required to overcome the friction in boiler or superheater tubes. This amount of energy fluctuates with boiler load and furnace conditions, as, both from the standpoint of engine operation and cooling effect on the tubes, constant superheat is desired. Faster circulation means lower superheat, and vice versa. The energy supply must be readily adjustable.

Mr. Firing provides a jet pump in which expanding steam is the working medium, coming from a Benson tube system. The latter, preferably subjected to radiant heat, according to the proposal, must be fed by a separate pump, working against a pressure above the critical; pure feed water might be obtained from a steam transformer, as in Mr. Firing's sketch of a non-condensing plant.

It can readily be seen that special measures are necessary here to secure independent regulation of the steam flow through the Loeffler part. To maintain the pressure in the Benson tubes, their feed must be automatically controlled by this pressure, a characteristic Benson feature. The amount of steam that can be taken from the Benson part, and, therefore, the energy available from the jet pump, is a function of the heat transmission to the Benson tubes; regulation at will is possible only if sufficient excess energy is provided for; it will probably be advisable to combine an unadjustable jet pump with a bypass and throttling arrangement so as to have the reserve part of the Benson steam constantly flowing through the bypass into the Loeffler cycle. N. Artsay in his comment in the May 6 number even proposes a separately fired Benson system to solve the problem of independent control.

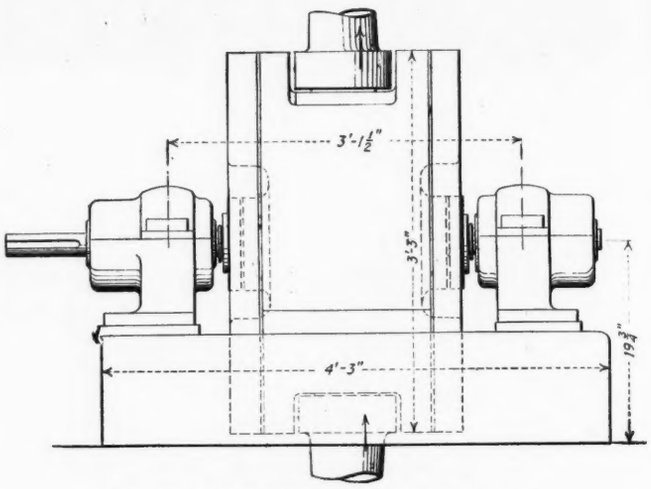
Failure of the circulating pump in a Loeffler boiler does no damage. The tube system can be cooled by letting steam from the drum flow through the tubes into the atmosphere. With the proposed additional Benson system, means should be provided for cooling it in case of failure of the Benson feed pump. This leads to inconveniences, especially if, as is to be expected, no water from the Loeffler drum can be allowed to enter the Benson tubes, where it would deposit scale. Blowing through the Benson part with steam, however, would make it difficult to permit starting the Benson process after temporary failure: The tubes are in danger of overheating during the change from steam cooling to the water cooling effected by the feed pump.

Loeffler provides circulation from a mechanical pump driven either by steam or electricity. The only regulation required is in the number of revolutions. There is nothing else to do about it. The simplicity of this arrangement can hardly be made more apparent than by comparing it with the complete Benson installation that could eventually be used to replace the circulating pump.

A test installation at the Witkowitz iron works in Czechoslovakia showed that a combustion chamber for pulverized fuel can be formed completely of steam-cooled Loeffler units with or without refractory walls.

From the standpoint of energy consumption, Mr. Firing's scheme is satisfactory; but the saving that could be effected in this way is negligible, as the mechanical pump requires only from 2 to 4 per cent of the plant's total power output.

The mechanical circulating pump has a simple duty to perform: It discharges dry steam of only 600 to 660 deg. against a pressure difference up to 60 lb. (not 100 to 400 lb. as in Mr. Artsay's estimate of superheater resistance). The simple one-stage rotary pump shown in the accompanying illustration, running at 6,000 r.p.m. and measuring less than 4½ ft. in length, supplies the circulation in a boiler of 66 tons per hour steam capacity, sufficient for 16,000 kilowatts.



Rotary "steam pump" for Loeffler boiler of 66 tons' hourly steam capacity

It is too unfortunate that his destiny called Professor Loeffler away from us before he could witness the real spreading of his ideas. With admirable foresight he discarded century-old methods as unsuited for the new problems of super-pressure steam. He had the rare genius of freeing himself from mechanical tradition.

New York City. DR. A. GIESL-GIESLINGEN.

The Cold-Water Test on Boilers

REFERRING to the editorial in the June 17 number of *Power* regarding "The Cold-Water Test on Boilers," I fail to see why a properly designed boiler should not successfully withstand a test pressure of 150 per cent of working pressure.

Boilers are built cold of materials the strength of which is determined cold. The cold-water test pressure duplicates conditions under which the boiler was built, and since the factor of safety in the design is 5, there should be no difficulty experienced at 1½. It is not clear in what respects the 150 per cent pressure test introduces abnormal stresses.

On the other hand, when the boiler is operating it is subjected to temperatures which cause stresses not existing when the boiler was built, and it would appear that what your correspondent calls normal working limits would impose more severe stresses than the cold pressure test.

It is true that some boilers leak after a few pressure tests have been applied, but I feel this is due to poor workmanship and design rather than to the severity of the tests.

I think Capt. C. H. Dinger, U.S.N., aptly expresses the cause of many boiler failures in his article which you published June 3, 1930, in which he says:

"Stress concentration can be produced in many ways. In a riveted joint it can be produced by a too-high pressure in forming rivet, by plates not fitting properly, by burrs left between the joints, by having rivets force plates into position, by bending below the elastic limit."

Philadelphia, Pa. EUGENE P. KIEHL.

Adapting the Boiler Room Bonus to the Industrial Plant

I WAS much interested in the article by W. A. Schwerin in the May 20 number on "Adapting the Boiler Room Bonus to the Industrial Plant." I should like to outline briefly what we have done at our plant along similar lines.

The bonus worked out in the case referred to is based on the amount of fuel burned per unit of production (kill-day). It is therefore necessary for both the firemen who produce the steam and for the men who control consumption of the steam to participate in it to make it most effective; for increased efficiency in the production of steam may be partly or wholly offset by decreased efficiency in the consumption of steam. I believe that good results would be obtained by giving separate bonuses to the producers and to the users of steam; and even better results would be obtained by giving individual bonuses based on the efficiencies of the individual men, if that can be determined.

We are not told just what results were obtained in this experiment other than that fluctuations in fuel burned per unit have been greatly reduced. We are to assume that a reduction of over 13 per cent below the best previous results has been made in fuel consumption since the standard of five gallons of oil per head killed was established. It would be interesting to know what the actual consumption of oil is now. If the bonus system is actually put into effect, still better results are sure to follow. The spirit of contest has improved efficiencies. Increased earnings for the men will mean additional increases in efficiency.

We operate our boiler plant on three eight-hour shifts, one fireman to each shift. When we first started calculating and recording daily the pounds of steam produced per barrel of fuel oil on each shift, we found large fluctuations in this figure from shift to shift, day to day, and month to month. These fluctuations were due to variations in steam loads, to inaccurate results obtained from trying to measure the output of all five boilers with one steam meter (with load varying from 3,400 to 40,800 lb. of steam per hour), and to varying efficiencies of the firemen.

We installed individual meters on all boilers. In the next three months our evaporation per barrel of fuel oil was approximately 4,029, 3,937.2, and 4,001.8, respectively, for a weighted average of 3,986.5. This represented an efficiency of 67.8 per cent. Up to the end of that period the practice was to send the results daily to the chief operating engineer. He studied them, tried to determine how to raise the average, and talked with the individual firemen as seemed necessary.

At this point we decided to post the results daily on a blackboard in the boiler room. Results of each shift were posted throughout the week and the weekly averages were given. The results for the next three months were 3,910, 4,032.4, and 4,158.2, respectively, for a weighted average of 4,039.2, or 68.7 per cent efficiency. The men apparently tried too hard the first month, but gradually improved through the second and third months, and they have never fallen below 4,151.4 since the second month of this period. For the eighteen months that results have been posted the average pounds of steam per barrel of oil is 4,202.4, or 71.5 per cent efficiency.

Recently I studied the results of the individual firemen over a period of thirty weeks, and found that *A* produced 4,273.8; *B*, 4,231.3; and *C*, 4,129.3 lb. of steam per barrel of oil for this period. Weighted average for the three, for this period, was 4,209.2, or 71.5 per cent. With fuel oil at $1.05 a barrel, I estimated that *A* was burning 6.46c. less in oil an hour than *C*, and *B* burned 4.61c. less than *C*. The men were all paid the same rate per hour. We decided to pay different rates to the men, according to the efficiencies. We left *C*'s rate alone, increased *B*'s 2c. an hour and *A*'s 4c. an hour.

I have insufficient results since these rate changes to compare the men fairly with one another. *C* has been much favored over *A* and *B* in steam loads in the nine weeks that have passed. *B* has a distinct advantage over *A* in the same way. Their results however are: *A*, 4,345.2; *B*, 4,386; and *C*, 4.321.4 lb. The weighted average is 4,352, or 74 per cent efficiency. The increase in efficiency of all three men since the new rates were made effective represents, in oil saved, over three times the wage increase.

The question naturally arises as to what the next step will be. The present rates will be given a fair trial for at least six months. We expected them to bring out about the best in the men. I think this has been done. Just how far we can go with further rate changes we cannot tell now. If a bonus system is eventually required to give the men an incentive for their best efforts we shall be better able to set a standard as a result of what we have already done.

A bonus to be paid weekly is difficult to figure in our case, because of the extreme variations in the steam load and consequent variations in efficiencies except over long periods of time.

We find pounds of steam per barrel of oil burned is a much more satisfactory basis for measuring the men's abilities than per cent CO_2. We cannot figure a bonus on steam consumed, because our production in all departments is about as variable as our steam load, not only as to quantity, but also as to other factors. No department in the plant works on a fixed schedule.

G. E. LEVITT, JR., *District Engineer*,
Bayonne, N. J. Southern Cotton Oil Company.

Carbon Monoxide Gas in Diesel Engine Crankcase

NOT HAVING SEEN anything published on the hazards of carbon monoxide gas which collects in the crankcases of Diesel engines, I should like to submit the following:

It is a dangerous practice for men to enter the crankcase of a Diesel engine as soon as the doors are removed, owing to the concentration of carbon monoxide gas in quantities large enough to be fatal.

After removing the doors a crankcase should be allowed to ventilate for several hours. If time cannot be spared, electric fans or blowers should be placed in one door opening to thoroughly scavenge the gas from the crankcase. This gas is of an explosive nature, so all open flame lights should be kept away.

If a workman should get an overdose of this gas, one teaspoonful of common baking soda in a glass of water can be given, providing the person is fully conscious. Artificial respiration should be administered if the victim is unconscious.

WM. W. DINGWALL.
Walthill, Neb.

From Among Readers' Problems

Conducted by

L. H. MORRISON

CORROSIVENESS OF BRINE-CONTAINING AMMONIA — *We have two brine ice-making tanks. One is a 16-ton salt-brine (sodium-chloride) tank. Its ammonia coils developed a leak with a discharge of about 500 lb. of ammonia into the brine. The other is a 12-ton calcium-chloride tank. While repairing the leak in the coils of the salt-brine tank it is proposed to transfer the brine to a calcium-chloride tank, from which we would temporarily remove the cans. If the brine mixture is subsequently used in both tanks will it have a bad corrosive effect on the galvanizing of the ice cans, especially from the presence of the ammonia?* N. F.

Mixing the two brines will not have any bad effect on the cans. Calcium-chloride brine is, of course, better than sodium-chloride (salt) brine. The salt brine will cause corrosion or rust on the can if the brine level varies to any extent, with alternate flooding and exposure of part of the can to the air. So far as known, the ammonia will not destroy the galvanizing on the cans. Although there are cases where hot ammonia gas has eaten the galvanizing of condenser coils, cold ammonia should not.

WASTE RESULTING FROM INSUFFICIENT HEATING SURFACE FOR STEAM KETTLES—*We have a number of open kettles that are heated by pipe coils supplied with steam at 125 lb. boiler pressure reduced to 40 lb. gage. The operators claim that for proper results it is necessary for the heating coils to blow to the atmosphere. Should not as much heat be obtained by discharging the condensation through traps or by a gravity return system?* A. P.

Blowing the coils to the atmosphere, there is more active circulation of the steam, as the coils are kept clear of air and water, and there is more rapid transfer of heat to the contents of the kettles. The process is highly wasteful of steam, but if it is desired to obtain the same heating results with drainage of the condensation only, either by a gravity return system or by discharge traps, it will be necessary to increase the present amount of heating surface, and the pipe coils will have to be suitably arranged for drainage of condensate and equipped with air valves.

HIGH AND LOW HEAT VALUES—*What is meant by "high" and "low" heat values of a fuel?* V.M.

A pound of hydrogen burned in an inclosed calorimeter in which the resulting water vapor is condensed will produce 62,000 B.t.u., as in a bomb calorimeter the water vapor resulting from the combination of hydrogen and oxygen is condensed and cooled to the calorimeter cooling water temperature. This heat is then measured along with the other heat of combustion. But in an actual furnace this water vapor passes up the stack with the flue gases and its latent heat is not absorbed by the boiler. Therefore, to estimate the true available heat of the coal, a deduction, depending upon the percentage of hydrogen, would have to be made from the calorimeter value, giving the so-called "low value."

Heat balances are however, usually figured on the "high" or calorimeter value, and the difference as calculated for the particular boiler conditions is enumerated as a "loss" against the heating value. The loss is, of course, unavoidable, although it is larger at high flue temperature.

A Question for Our Readers

WE HAVE opportunity to purchase a second-hand 250-hp. engine for $1,050. The seller states that the full-load steam consumption is 30 lb. per brake horsepower-hour. A new engine-generator unit would cost $12,000 but the steam consumption would only be 20 lb. per brake horsepower-hour. If steam costs 40c. per 1,000 lb. and the engine will run 2,000 hr. per year, which is the better purchase? C.P.M.

Suitable answers from readers will be paid for and published in the Aug. 19 number

SUPPLEMENTING EXHAUST WITH LIVE STEAM — *When the exhaust steam supplied to the heating apparatus of a building does not furnish enough heat for the coldest weather, should live steam be used exclusively, or may live steam be turned into the exhaust to make up the necessary amount of heat?* B. N.

It should not be concluded that there is insufficient exhaust to do the heating unless there is little or no relief of steam at the back-pressure relief valve. When it is found that good circulation in coils and radiators cannot be obtained without increasing the back pressure, it will pay to increase the back pressure to the point where the engine's capacity becomes less than the required load, rather than to use only live steam for the heating. When the necessary back pressure has been reached, the exhaust may be supplemented with enough live steam to accomplish the heating without affecting the engine's operation.

The live steam should be supplied through a pressure-reducing valve that will restrict the supply to a pressure that is several pounds below that at which the exhaust back-pressure relief valves open. Otherwise there is likely to be waste of steam to the atmosphere at the back-pressure relief valve, especially at times when the load on the engine is increased with increase of available exhaust.

PRACTICABILITY OF CAST-IRON STACK —*In our power plant, having six horizontal return-tubular boilers and three 45-in. steel smokestacks, the life of the stacks averages about five years.*

Owing to unstable soil the expense of a concrete stack would be prohibitive. It has been proposed to build a cast-iron stack ½ in. thick, 70 in. diameter, and 65 ft. high. Is such a stack advisable? J.J.D.

The casting of the 70-in. diameter circular sections would be difficult if the metal was held to ½ in. thickness. Probably each section would need be cast in four segments. It is evident that such a stack would be expensive.

As a concrete stack is prohibited by the ground conditions, steel stacks are the most suitable. Even with a life of five years, the cost of the steel stacks should not exceed the carrying charges on a concrete stack or on a cast-iron stack. Semi-annual painting of the stacks both inside and outside should lengthen their life to some extent.

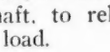
Under the circumstances, a cast-iron stack cannot be recommended, due to its first cost.

ELEVATOR MOTOR BEARING BURN-OUT—*We have been having trouble with the bearing on a worm-gear type elevator motor overheating and burning out. What is the cause? The bearings are the sleeve type, lubricated by oil rings.* E.N.

There are a number of possible causes. The bearings may be out of line and be binding on the shaft. The bearings may not be getting sufficient lubricant. The oil return passage under the bearing may be closed with dirt. When the oil comes into the end of the housing, after passing through the bearings, it cannot return to the reservoir and flows out of the housing. In a short time the bearing will run dry and hot.

Perhaps the oil rings do not run freely on the shaft, due either to dirt in the oil or to the rings not being round. The bearings should be thoroughly cleaned, the oil renewed, and the rings checked for round. If they are found to be out of round they should be replaced.

On worm-gear elevator machines, thrust bearings in the gear case take the thrust load on the worm shaft. When the thrust bearing next to the motor wears, it may allow the motor bearings to take the thrust load. These bearings are not designed for that load and may overheat. A check should be made, and if the motor bearings are taking the thrust load the thrust bearing should be adjusted or renewed. With the coupling bolts removed, it should be possible to pull the motor armature endwise a short distance from the brake wheel. If this cannot be done, with the worm shaft pushed toward the motor as far as possible, it shows that the motor bearings are taking the thrust. Sometimes it is possible to set the coupling further on the motor shaft, or the brake wheel on the worm shaft, to relieve the motor of the thrust load.



THREADED PIPE JOINTS—*What is the best method to make up threaded ammonia piping joints?* H.R.

Thoroughly clean the fitting. Thread must be free from grease and oil, and the metal comprising the solder box or recess around the thread in the fitting must be bright. The threads, about $\frac{3}{4}$ in. back from the end of the pipe, must be ground or filed so as to show bright metal, and, likewise, made thoroughly clean.

Next, put some oil on the thread of the pipe and screw fitting or flange on to the pipe, taking care to line up the flange with regard to the bolt holes.

Then, set the pipe connection up on end in such a way that the solder box will be level. Expose the joint to at least two flames of torches, blow lamps, or Bunsen gas burners, for at least 3 min. to thoroughly heat up the metal of the fittings and of the pipe. This will also serve to burn off any surplus oil.

While the flames are still playing on the joint, pour in a spoonful of acid. This is the usual acid used for soldering, and is composed of muriatic acid that has been "killed" or neutralized by the insertion of strips of sheet zinc, sufficient to stop effervescence.

A soldering hook is found very useful for tinning the joint. This hook may be made of a piece of $\frac{3}{16}$-in. round wire about 15 in. long, bent L-shaped, the leg being about $1\frac{3}{4}$ in. long and flattened out like a hatchet. Dip the hatchet end of the hook into a tray containing acid, and from there dip it into a tray containing powdered sal ammoniac, and work the hook around the joint in the solder box; then take a stick of solder and work that around the joint in such a way that the entire surface comprising the solder box and the bright part of the pipe will be thoroughly tinned. When that has been done, the stick of solder may be rubbed around the joint, the heat of the metal causing the solder to melt and thus gradually fill up the solder box. When nearly filled up, take a piece of lump chalk and rub it around the beveled edge of the solder box of the fitting to prevent the solder from overflowing. Continue with the stick of solder to fill up the solder box as much as possible, finishing with a smooth fillet.

Now the blow torches may be removed and the point allowed to cool, which will take but a few minutes. Before it is entirely cold, clean off the joint with a brush or rag.

The best results are obtained by using a thin stick of solder composed, by weight, of half tin and half lead.

If a number of joints have to be made, soldering is facilitated by using a bath composed, by weight, of 50 per cent tin and 50 per cent lead, into which the fitting and pipe can be dipped for heating. Otherwise the pipe and fitting will have to be heated by two or more blow lamps or torches, and the threads tinned, tinning the pipe about $\frac{3}{4}$ in. back from the thread, with acid and sal ammoniac.

First, tin the pipe and afterward the fitting or flange. This must be heated to a high temperature and quickly screwed on to the pipe as tightly as possible, the idea being that the heated flange is expanded by heat and will practically make a shrink fit. Then fill up the solder box with solder.

When possible, pipe joints should be made at the bench, not in place.

Modern practice is turning more and more to welded joints in preference to flanged ones. When done by a qualified welder such joints are excellent and are about as cheap as flanged ones.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

IN CONSIDERING the relative values of expansion loops and expansion bends, to care for expansion in steam piping, the following statements seem correct. . . . The bend giving equal flexibility with a loop is costlier, harder to make, and requires more pipe.

If the statements are true, why are bends almost universally chosen? These facts surely more than balance the disadvantage of offset flanges, and the loop can be made to bring the flanges in line. W.T.H.

IN A BEND all of the piping is in the same plane. Consequently by laying the bend in a horizontal plane, the pipe line can be installed in a continuous line without forming a pocket in which water of condensation can collect. To obtain the same results with a loop, vertical offsets are necessary, and these necessitate a loss in headroom.

If the loop is so formed that the flanges are in line, the pocket cannot be avoided. Furthermore, to bring the flanges in line, the length of pipe outside the loop proper must be increased, and a compound bend formed. In the latter case, there is introduced into the loop the very same disadvantages that it was aimed to avoid.

HOWARD LIVINGSTON.
Los Angeles, Cal.

EXPANSION BENDS have received the more extended application because from a practical standpoint they are more suitable. While an expansion loop has advantages over a bend, these are more theoretical than practical.

The majority of bends in power plant piping are made in the run of piping and serve not only as expansion bends, but also to carry the pipe into position. There is also smaller possibility of water-hammer. Expansion loops will only serve the purpose of giving expansion, whereas a bend can, within limits, be made of suitable radius to fulfill the joint purpose of providing expansion and enabling the pipe to follow the most convenient course. These advantages make bends much more adaptable to power plant conditions, loops only showing up to advantage where expansion is needed in long horizontal pipes. W. E. WARNER.

London, England.

*Developing the Super-Power System of Chicago District**

Over a period of 29 years average coal consumption per kilowatt-hour in the Chicago district has been reduced from 7 to 1.7 lb. During first three months of 1930 the heat rate of all stations has been 16,400 B.t.u. Powerton station has shown a six months' average of 12,610 B.t.u. per kilowatt of output.

BEGINNING with the old Adams Street station of the Chicago Edison Company, which went into operation in 1888 as a non-condensing, high-speed, engine-driven plant to which coal was delivered by wagon, the author traced the development in boilers and turbines, station by station, charted the growing capacities, the improving economy and the increasing use of current per capita. Details were included of the 132,000-volt interconnecting tower-line system. Crawford Avenue, State Line and Powerton stations were specially featured, as they best indicated the recent advances in power-plant practice.

Of these three stations, Crawford Avenue was the first in which the advances talked of during the war were put into effect. Steam pressure was increased to 550 lb., steam temperature to 725 deg., and reheating of inter-turbine steam was begun. An anticipated increase of 15 per cent in fuel efficiency over that of Calumet station was delayed, owing principally to corrosion of economizers caused by the sulphur in the coal. Within recent months the station has been fulfilling expectations, as it is now operating on about 14,600 B.t.u. per kilowatt-hour. With six cross-compound turbine units, it has a total capacity of 424,000 kw. In December last the station had an output of over 200,000,000 kw.-hr. for the month. Although there are a few stations that are larger, this output is considered a world's record for a month.

State Line and Powerton stations were much alike in many ways, except in the matter of capacities. After the possibilities of the unit mill system had been demonstrated at Calumet station, pulverized coal was adopted for both of the foregoing plants, to improve boiler plant efficiency and to permit of installing larger boiler units than were practical with the type of stokers used in previous plants of the system.

There are six boilers serving the first State Line unit, each having about 2½ times the maximum capacity of the largest stoker-fired boiler at Crawford Avenue. At Powerton reheat boilers are used, while at State Line, on account of the large volume of steam involved, reheating is done by live steam. This method does not give as high steam temperature as the boiler reheat, but is much easier and less expensive to install.

At State Line the 208,000-kw. compound turbine unit was selected because at the time there seemed to be a considerable advantage in efficiency, mainly on account of the large size of the high-pressure turbine, 76,000 kw., in comparison with the largest units at Crawford Avenue. The combination of large turbine unit and large boilers made an important reduction in first cost.

Fig. 1 shows the growth in the size of turbine units and generators, from the 5,000-kw. units of the first Fisk Street installation. Eventually the turbines and generators became of a standard size, until the use of cross-compound units with separate high- and low-pressure turbines and independent generators was begun in the Crawford Avenue station. The large compound turbine had the possibilities of considerable improvement in efficiency over the smaller machines, and it was impossible at the time to get generators sufficiently large for the entire capacity of the turbine unit.

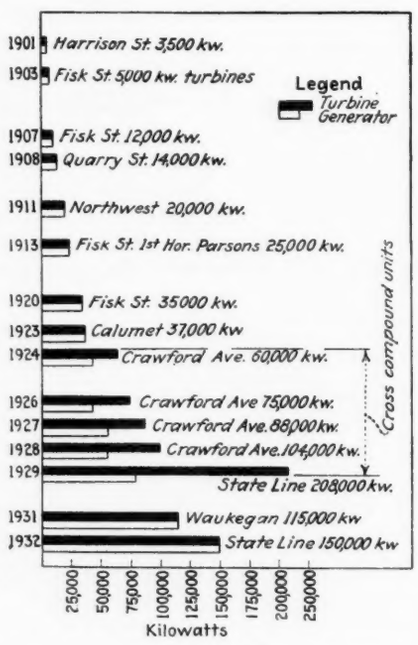


Fig. 1—In the order of the years, largest turbine-generator units in Chicago district

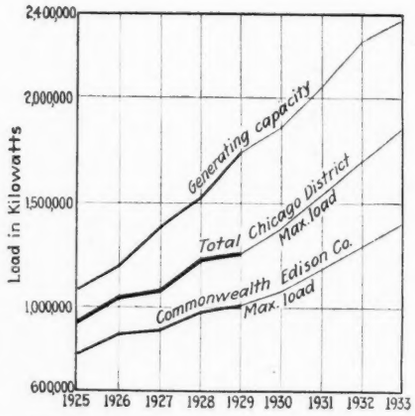


Fig. 2—Maximum loads and generating capacities since 1925

In the last few years, however, there has been a rapid improvement in generator design, more particularly in the windings and in methods of ventilating to remove the heat loss. This has led to the development of the large tandem-compound turbines with separate high- and low-pressure turbines on the same shaft, and with but a single generator. The fifth unit now being installed at Waukegan is a tandem-compound of 115,000-kw. capacity with a single generator of that size. The third and fourth units now in course of construction for Powerton are 105,000-kw. machines of the same character, and early this year two new units were ordered for State Line; both tandem-compounds—one of 125,000-kw. and one of 150,000-kw. capacity. Other points about these units are that the improvement in efficiency of a turbine, owing to size, is not marked above 100,000 kw.; the tandem-compound unit costs less per unit of capacity than the cross-compound, and takes up less room in the building.

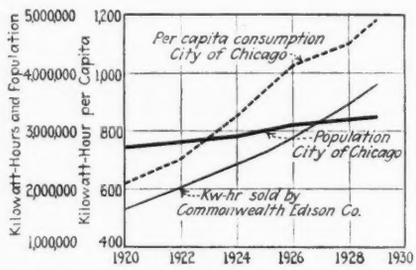


Fig. 3—Consumption of electricity per capita in Chicago

The State Line machines are to be

*Excerpts from an address by W. S. Monroe delivered at the sixty-first annual meeting of the Western Society of Engineers, May 22, 1930.

operated at 1,200 to 1,250 lb. initial pressure, 800 to 825 deg. F. initial temperature, with reheating at 400 lb. pressure to the same temperature. Providing the temperatures can be maintained, and the blade efficiency of the turbines is as good as in the present machines, 8 or 9 per cent improvement over the efficiency of the present units is anticipated. About one-quarter of this improvement will be due to the increase in pressure, and the rest to the higher temperature. Reheating is just another means of adding temperature after the steam has given up some of its heat in the form of work. If it were practical to do so, the same efficiency might be obtained by starting with an initial temperature of about 1,050 deg. F. and doing away with the reheating. This would give the same steam quality at exhaust.

Fig. 2 compares the growth of the load and the capacity in generating stations in the Chicago district and in the city of Chicago. The city will have a peak load next winter of about 1,100,000 kw. The Chicago district will have 1,400,000 kw., and the capacity of the generating stations will be 1,855,000 kw. Continuing the lines on the diagram (Fig. 2) to 1933 indicates a probable load in the city of Chicago of nearly 1,400,000 kw. by that time, 1,800,000 kw. for the Chicago district, and power station capacity of nearly 2,400,000 kw. In this connection the companies included in the Chicago district now own power station sites on which it is possible to develop stations having a total capacity of about 7,000,000 kilowatts.

Fig. 3 shows the population of the city of Chicago from 1920 to 1930, the total energy sold for the same period in kilowatt-hours, and the energy sold per capita, which last year amounted to 1,190 kw.-hr. For several years past the increase in Chicago has been at an almost uniform rate of 70 kw.-hr. per year per capita.

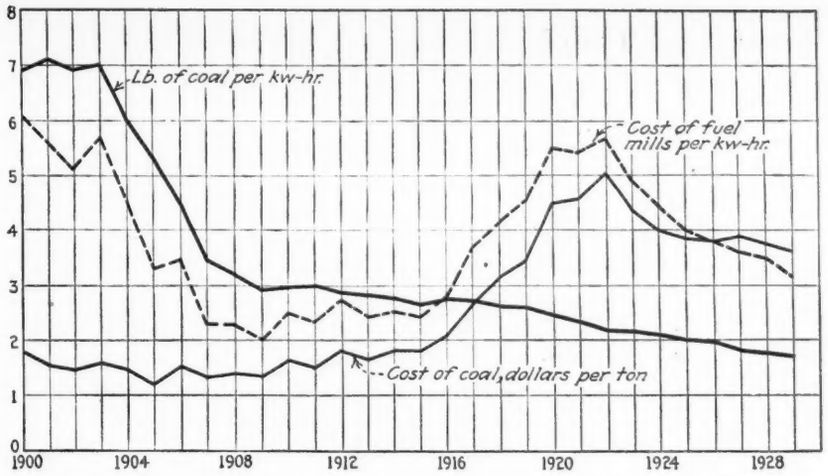


Fig. 4—Coal consumption per kilowatt-hour and cost of fuel in Chicago District

Fig. 4 illustrates the fuel economy in the Chicago district from 1900. The rapid decline should be noticed in the pounds of coal per kilowatt-hour for the six or seven years after Fisk Street station first went into operation. In 1911 the consumption was 3 lb. per kilowatt-hour. Since then the decline has not been so rapid, but continuous, until this year the average consumption is 1.7. In this same diagram it is interesting to notice how the operating costs went up during the war period with the rapid rise in cost of coal, and fell off with the drop in cost of coal since 1922.

The improvement in fuel efficiency since 1920 in B.t.u. per kilowatt-hour is shown in Fig. 5. The coal burned averages about 10,000 B.t.u. per pound. The diagram also shows the "heat-rate" of Crawford, Waukegan, State Line and Powerton stations, which form the foundation of the Chicago system power supply. The other stations, Calumet, Fisk Street, Northwest, and Quarry, are now more or less reserve or stand-by plants.

The output of the Chicago power system for the year 1929 was a little over 5½ billion kilowatt-hours, and for 1930 will be about 6 billion. Chicago's power system is outranked only by that of New York City and the Niagara Falls-Buffalo system, including the Canadian plants at Niagara Falls.

For the first six month of 1929 the average heat rate of all the stations of the Chicago district was 18,050 B.t.u. per kilowatt-hour, and for the last six months of 1929 it was 16,780 B.t.u. per kilowatt-hour. For the first three months of 1930, however, this figure has dropped to 16,400, State Line and Powerton being chiefly reponsible.

The most efficient station on the system is Powerton, which for the past six months has shown an average efficiency of 12,610 B.t.u. per kilowatt-hour, and has generated an average output of 55,341,450 kw.-hr. per month. State Line station has not as yet shown quite so good efficiency, owing to trouble with the high-pressure turbine and other minor difficulties. It is operating now on about 13,300 B.t.u. per kilowatt-hour, and when adjustments are completed should about equal the efficiency of Powerton, given a similar load condition. But Powerton has the benefit of a much lower cost of coal, so that, naturally, it is given a better night load. If a high-grade coal with low ash and moisture were used in the Powerton station the efficiency would be about 12,000 B.t.u. per kilowatt-hour.

It is safe to say that the six months' record of Powerton station has never been equaled, and its output per 1,000 kw. of capacity installed is also a world record. The station meters and the methods of weighing, sampling, and testing the coal of all the stations were calibrated recently and checked by impartial experts.

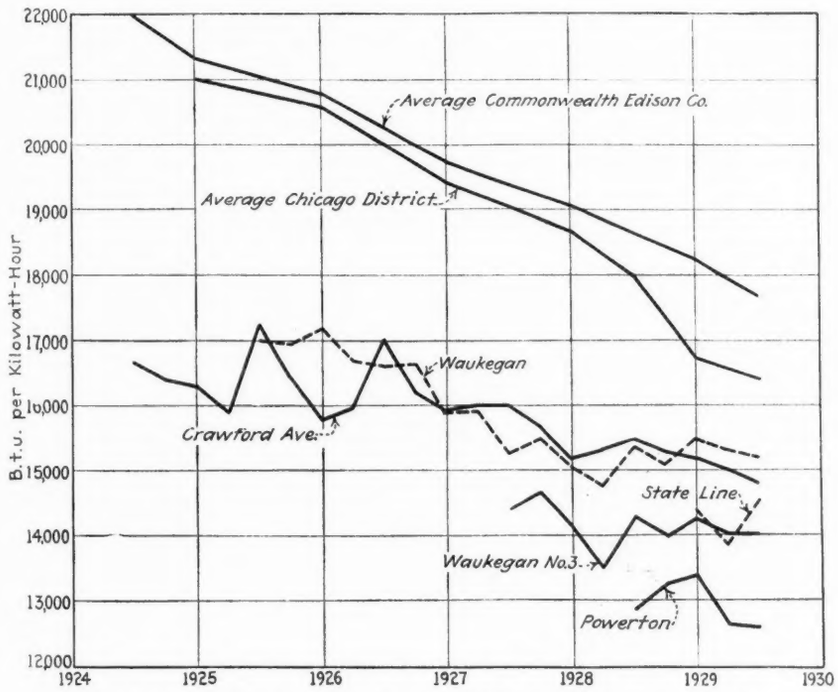


Fig 5—Average heat rate of city and district and of leading stations

European Developments in KAPLAN *and* PROPELLER TURBINES

By A. V. KARPOV
Designing Engineer, Hydraulic Department, Aluminum Company of America

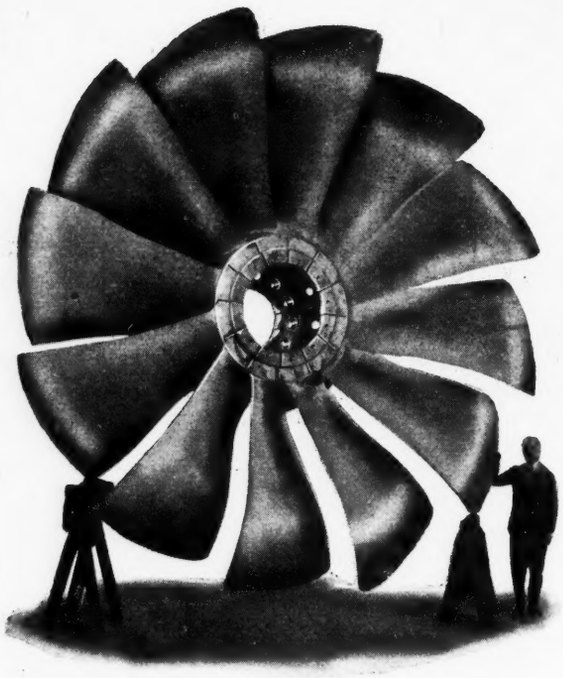


Fig. 1 — Turbine runner of a design between a Francis and propeller type

MODERN European hydro turbine designs are confined to Pelton, Francis, propeller, and Kaplan types. The general tendency is to narrow the field of Francis turbine applications. Only a few years ago this type was used for very low as well as for medium and high heads. Today the propeller and Kaplan turbines are used entirely for low-head developments. At the same time, the Pelton turbines, by increasing the number of jets and runners, are used for much lower heads than previously. This leaves the field of medium-head developments for the Francis turbine. The specific speed curves, Fig. 3, give an approximate idea of the heads and specific speeds for which different types are used.

Of modern designs, the most interesting are the propeller and Kaplan. Strictly speaking, both are propeller types. In the propeller turbine the runner blades are solidly connected to the hub, Fig. 5. The blades of a Kaplan turbine can be adjusted for different operating conditions by a mechanism built into the runner's hub, Fig. 6. There is no particular limit to the size, shape, and number of runner blades of a propeller turbine. For the Kaplan turbine, the size and shape of the blades must be such as to prevent any interference of one blade with another, and to insure a proper hydraulic passage at different loadings. The number of blades is also limited by the size of the adjusting mechanism that can be placed in the hub of the runner. The advantages of these types of turbines, on account of higher specific speed and efficiency, are such that, up to the heads to which they can be safely built, they are replacing the Francis type.

Cavitation is the chief factor that excludes propeller and Kaplan turbines for heads above 80 ft. Laboratories have been built for studying these phenomena, and the results are being applied not only to propeller and Kaplan turbines, but also to the Francis type.

Cavitation occurs when the pressure in some parts of the turbine drops lower than the evaporation point of the water and causes the formation of bubbles of vapor, supplemented by air that was in solution in the water. These bubbles cause a loss in efficiency, pitting of the runner, and vibrations. It seems that roughness of the material, cracks and even changes in the structure of the material due to concentrated internal stresses, may produce or increase cavitation. A destruction of the runner's material increases cavitation (which, in turn, further aggravates conditions), as well as decreases the efficiency and increases vibration. No cavitation should occur in a properly designed turbine.

In Francis turbines, the water is smoothly guided, and the pressure drop from the guide vanes, where the water enters the turbine, to the draft tube, is fairly uniform. The highest pressure is where the water enters the turbine, and the lowest pressure is at the top of the draft tube. To prevent cavitation in such a design, it is only necessary to have the pressure at the draft-tube entrance higher than the evaporation pressure. The pressure drop at the draft-tube entrance depends on the draft-tube head and efficiency, and on the velocity of the water. If these conditions are properly met, cavitation is prevented. In the high-specific-speed Francis turbines first introduced in the United States the water is not as smoothly guided as in the old designs; the pressure does not change gradually from the wicket gates to the draft tube, and the point of lowest pressure may be transferred from the draft-tube entrance to some point on the runner. In such designs it is usually possible, by changing the shape of the runner buckets and decreasing the draft-tube head, to eliminate cavitation.

In the propeller and Kaplan turbines the point of lowest pressure is always above the draft-tube entrance, being somewhere on the runner blade. Fig. 7 shows the characteristic pressure distribution on the surface of a Kaplan turbine runner blade, the section being taken at the line *CC*. The values along the surface of the blade and the pressure curves are to be considered as coefficients only. The actual pressures depend on the water velocity and draft-tube head. For this particular shape of the Kaplan runner the point *K* is where the lowest pressure occurs. Pressure at this point is always lower than at the draft-tube entrance and will decrease rapidly with an increase of water velocity. In a turbine of this type a sufficient pressure at the draft-tube entrance does not insure against cavitation troubles.

As the head increases, propeller and Kaplan turbines soon approach the limit at which even atmospheric pressure at the draft-tube entrance will not prevent cavitation. Today about 80 ft. repre-

▼

This article is part of a report made by the author after an extended trip through Europe. Cavitation problems are of such importance in the application of propeller and Kaplan turbines that laboratories have been built in which to study these phenomena. These studies have also been extended to Francis type runners. The complete report was presented as a paper at the summer convention of the American Institute of Electrical Engineers in Toronto, Canada.

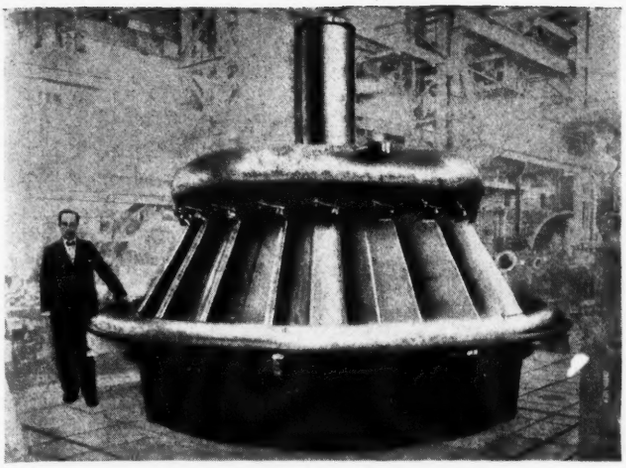


Fig. 2 — Inclined wicket gates used on high-specific-speed turbines

sents the upper limit of head for these turbines. If the runner were placed below low-water elevation, the head might be increased, but the cost of construction would also go up. Another plan is now under consideration: namely, to use two turbines in series, so as to have the first one working against a positive pressure.

Modern economical turbine design requires that the limits at which cavitation will occur be closely approached. Not only proper design, but also a very careful construction are necessary to prevent cavitation. High manufacturing standards exist in the leading European shops. The tendency is to machine all parts of turbines that come in contact with moving water. Blades of large propeller turbines are cast or forged separately from the hub and shaped so that they will permit of machining. The finished blades are bolted to the hub, Fig. 5.

Cavitation studies were originally made on propeller and Kaplan turbines. These studies have proved beneficial for the Francis type. At one of the leading manufacturing plants having a cavitation laboratory models of new Francis turbines, as well as propeller and Kaplan types, are tested to determine the limiting conditions at which cavitation starts. Actual operating conditions are chosen according to the results of these tests.

Improvement in design and efficiency of propeller and Kaplan turbines presents some interesting features. Originally Kaplan turbines were built with only a few small, fixed runner blades. Water coming into a propeller turbine, particularly with a runner having a few small blades, is not guided, and good efficiency is obtained only for certain loads corresponding to the shape and angle of the runner blades. By making the blades adjustable, as in the modern Kaplan type, more favorable flow conditions for different loadings can be obtained, and a flat efficiency curve over a wide operating range results. In the flat range of the efficiency curve, the maximum efficiency that corresponds to the lowest eddy losses, falls somewhere in the middle section.

In a propeller turbine the number of blades can be increased and extended so that the water is partly guided. This will increase the friction losses, but may decrease the eddy losses. As the size of the turbine is increased the eddy losses increase faster than the friction losses, and in large units the maximum efficiency of a propeller turbine can be higher than that of a Kaplan turbine. Under certain conditions future extension of the runner blades will guide the water better and decrease the eddy losses so that a further improvement in efficiency will be obtained. The Lawaczeck turbine is built on this principle, and the maximum efficiency obtained from those machines in the Lilla Edet plant, Norway, are unsurpassed by any turbine of similar size and head. Fig. 4 gives approximate comparative efficiency curves for Kaplan, propeller, and Lawaczeck turbines of about 10,000 horsepower.

Water friction losses in a Francis turbine are largely due to the outside ring, which moves at right angles to the direction of the water. In propeller and Kaplan turbines this ring is eliminated, and the tendency is to do this also on large Francis turbines. Fig. 1 shows a large runner, of a design between the conventional Francis and propeller types, made in sections and bolted together without the outside ring. This runner was built to substitute for a more conventional Francis runner in the Chancy-Pougny plant on the Rhone River on the Franco-Swiss border. (This runner is rated at 10,500 hp. under a head of 33 ft. and operates at 83.3 r.p.m.)

An unfavorable characteristic of the first large-sized Kaplan and propeller turbines was their tendency to hunt. Tests indicated that this was caused by irregularity of the water flow in the draft tube, which increased with the size of the unit, shortening of the draft tube and the decrease of the radius of its elbow. Building a vertical partition in the draft tube, starting near the runner and following the axis of the draft tube, was found to be a cure for this trouble. This construction was indicated by Figs. 2 and 4 in the article "Low-Head European Hydro Developments," April 1, number of *Power*. Such a partition not only decreases hunting, but also increases efficiency, particularly at part loadings.

The results obtained with partitions encouraged future research, and other designs of draft tubes and scroll cases were tested. Tests proved that vertical partitions properly built into the draft tube below the elbow and in the scroll case have no bad influence, but improve the behavior of large turbines. This proved of importance in solving structural problems in building power houses for large propeller and Kaplan turbines; the vertical partitions act as piers

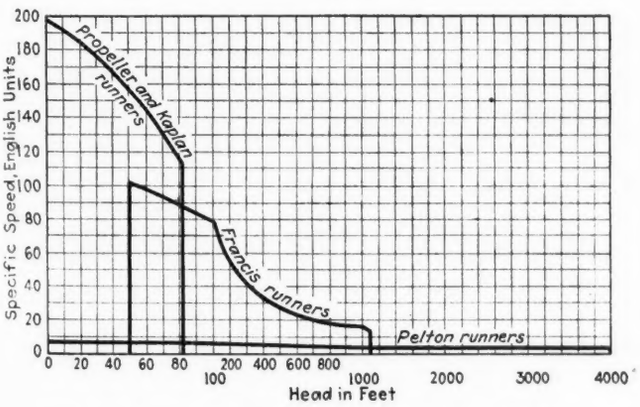


Fig. 3—Curves of specific-speed limits for propeller-, Kaplan-, Francis- and Pelton-type turbines

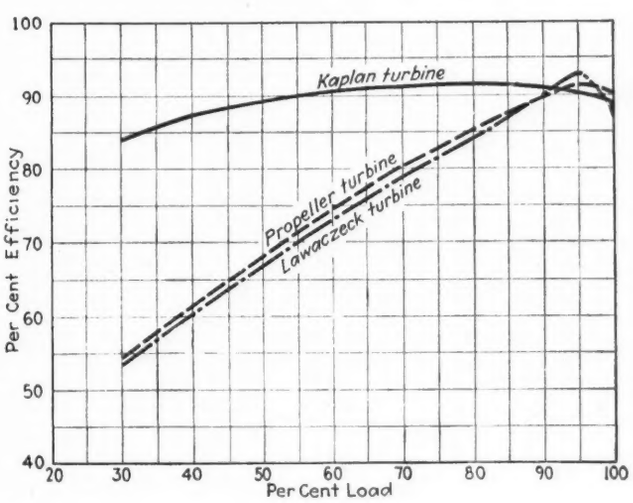


Fig. 4—Efficiency curves of Kaplan, propeller and Lawaczeck turbines

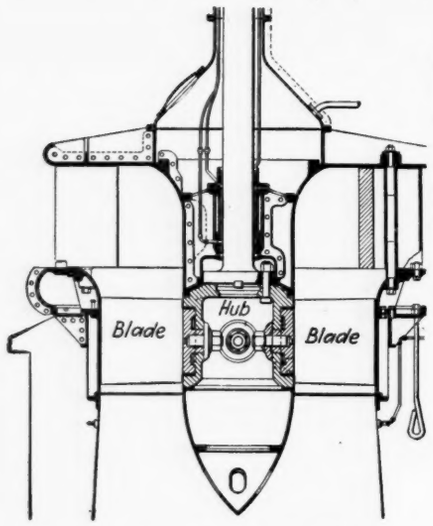


Fig. 5—Sectional elevation of a propeller-type turbine

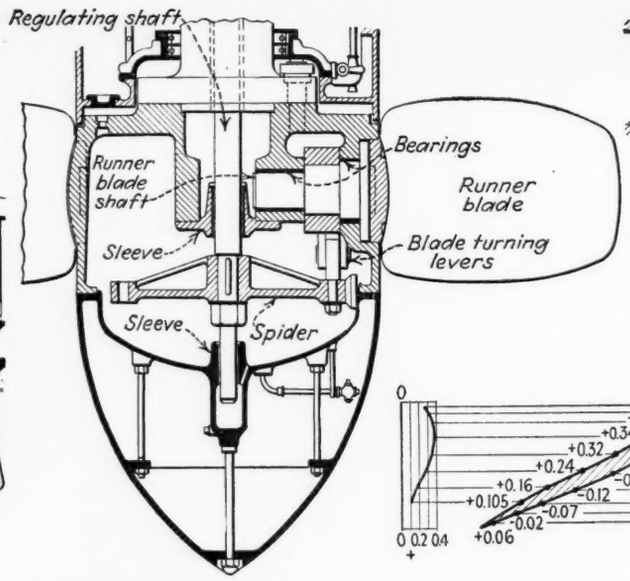


Fig. 6—Sectional elevation of a Kaplan-type turbine

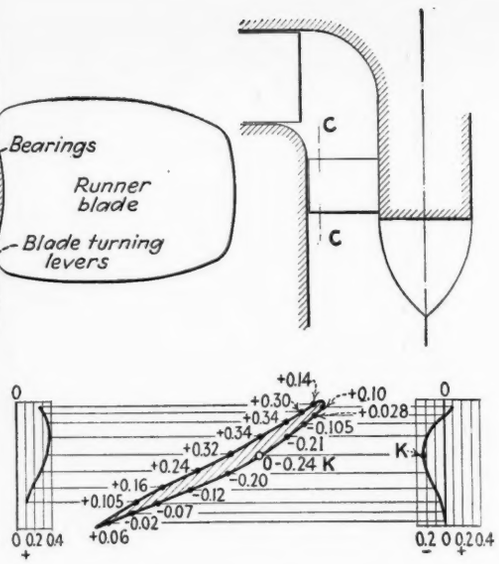


Fig. 7—Pressure distribution on the blade of a Kaplan turbine

to support the power house structure.

As the draft tube is an important factor in the efficiency of low-head installations, a large amount of laboratory research has been done on these parts. The old elbow-type draft tube, properly shaped and somewhat extended in the horizontal direction, seems to be superior for low-head development. Practically all the recent larger low-head developments that show high efficiency, as well as the new designs, are made with an elbow-type draft tube.

The most recent improvement in propeller and Kaplan turbine design is the inclined arrangement of the wicket gates, Fig. 2. This not only gives a considerable saving in the over-all sizes of the turbine, but in some cases improves efficiency. An inclined arrangement of wicket gates can also be applied to high-specific-speed low-head Francis turbines.

The position of the runner blades has to correspond to the position of the wicket gates for proper regulation of a Kaplan turbine. These positions are influenced by variations in head. Regulation can be accomplished either by simultaneous operation of the wicket gates and runner blades, or by making the regulation in two stages. In present designs the main regulation is accomplished by the governor acting upon the servo motors and changing the position of the wicket gates to keep the speed constant, at the different loadings, and a subsequent adjustment is made of the runner blades.

A cross-section of a modern Kaplan runner is shown in Fig. 6. The runner blades have an extended shaft end supported on two bearings. Between the bearings a lever arm fastens to the shaft and is connected by rods to a spider. The blades are turned by moving the spider up and down. The spider is solidly connected to a regulating shaft that can move up and down inside the turbine shaft. The regulating shaft is guided by two vertical sleeves, one above and one below the spider, and the inclosing case is filled with oil. The regulating shaft is moved by an oil-pressure servo motor.

In smaller Kaplan turbines the servo motor that moves the regulating shaft is above the generator, as in Fig. 8. Here the regulating shaft is continued through the hollow generator shaft and is connected with the piston of the servo motor. An indicating rod connected with the top of the regulating shaft extends above the servo motor and connects, by means of a system of levers, with the governor and a slide valve. The angle of the runner blades is indicated by the position of the indicating rod, and this indication is transferred to a specially designed governor. The latter is arranged so that if the position of the runner blades does not correspond to the position of the wicket gates, the slide valve is actuated and the regulating shaft is moved until the positions do correspond. To obviate adjustment of the runner at every slight movement of the gates, the runner blades' governor is made so that it has a time lag with reference to the governor actuating the wicket gates, and runner-blade adjustment follows only the major regulating movement of the wicket gates.

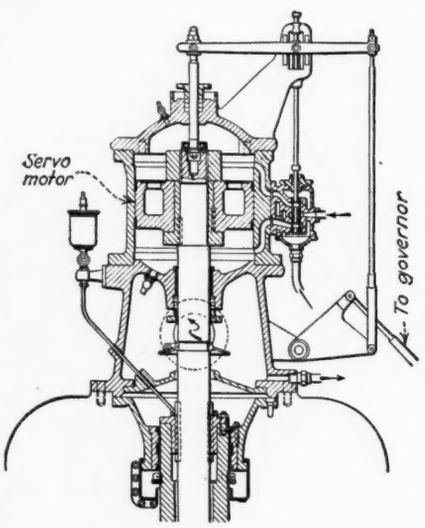


Fig. 8—Servo motor, to operate the blades on a Kaplan turbine, located on the top end of the generator shaft

This regulating arrangement has a number of features that are undesirable for large-sized turbines: The servo motor's piston rotates in a stationary cylinder; the long regulating shaft represents a heavy weight that has to be moved by each adjustment; and the hollow generator shaft has to be heavy to accommodate the regulating shaft.

The latest design in large Kaplan turbines, with the servo motor between the turbine and generator shaft, is expected to be a considerable improvement over the old. The regulating shaft is much shorter and the servo motor's piston rotates with the cylinder. The hollow generator shaft has to accommodate only two oil-pressure pipes for the servo motor. The central pipe is connected solidly to the regulating shaft, and the rod indicating the angle of the blades is connected to this pipe above the generator. Blade indication is transferred to the governor by a lever system. The servo motor is actuated by a special governor that changes the amount of pressure oil below and above the servo motor's piston until the angle of the runner blades corresponds to the position of the wicket gates.

None of these arrangements takes into consideration the influence of the head, and a hand adjustment has to be made for different heads. In general, it seems that the regulation of Kaplan turbines is still in a development stage. Improvements are necessary to get proper synchronization of both regulating mechanisms on a predetermined basis for different operating conditions. In line with general tendencies in governor design, those on the latest Kaplan and propeller turbines generally have electrically driven flyballs instead of a belt or gear drive.

*Increasing the Power of Diesel Engines By Supercharging**

By MAX ROTTER

THE air in a Diesel cylinder is compressed to about 6½ per cent of its original volume, attaining a pressure of 480 lb. abs. and a temperature of 880 deg. F. A given weight of fuel is burned in this air, say, at normal engine load, about one-half of the weight for which the air could supply the necessary oxygen. The volume of air and gases expands, with little increase in pressure, but with an increase in temperature to about 2,700 deg. F. The air and gases then expand to a pressure of about 50 lb. absolute, performing work equivalent to a mean indicated pressure of about 115 lb. per square inch of piston area. Should 50 per cent more fuel be burned in the same quantity of air, the temperature at completion of combustion would increase to at least 3,700 deg. F., too high for ordinary present-day materials and design. These conditions do not exist in a properly proportioned supercharged engine, in which the air excess is considerably greater than in a non-supercharged cylinder.

Supercharging, by which is understood the artificial increasing of the weight of combustion air with which the cylinder is charged before the fuel is injected, is gaining adherents. Witness the propelling engines installed by Harland & Wolf in the motorship Llangibby Castle, each engine normally rated at 3,200 b.hp., and capable of developing 4,250 b.hp. when supercharged.

The general idea of supercharging is quite old; 20 years ago Sulzer Brothers were experimenting with it, but were turned aside temporarily by more urgent lines of development, such as the two-stroke-cycle engine.

There are several systems of supercharging. The best known are the Rateau and the Buechi, in both of which the air is supercharged by centrifugal blowers driven by turbines using the exhaust gases of the engine. In general, these systems are similar to that developed in this country by Dr. Moss, of the General Electric Company, for supercharging aircraft gasoline engines to maintain sea-level air conditions at high altitudes and thus enable the engines to carry almost full load regardless of the rarity of the atmosphere. By proper adjustment of the compression ratio and the air excess, these supercharged engines are not subjected to higher temperatures or higher maximum pressures than those existing in similar normally charged engines; although, of course, the average cylinder pressures are higher. The pressure of the supercharging air is about equal to the pressure of exhaust gases, generally 18 to 20 lb. abs.; and the capacity increase of the engine is 30 to 40 per cent.

In the Buechi system the speed of the blower, and, therefore, the pressure of the supercharging air, automatically adjust themselves to the existing engine load due to the variation of the exhaust pressure with the load. The result is high efficiency, and a very flat fuel consumption curve. This system is suitable for continuous operation. To date it has been applied exclusively to four-stroke-cycle engines, although it might well be applied to certain types of two-stroke-cycle engines. The reason the latter has not been done lies in conflicting patent interests.

At present supercharging of Diesel engines is a controversial practice. Mr. Rotter outlines the several systems, pointing out the advantages and deficiencies of each

Distinguished from the former systems of supercharging, intended as a regular condition of operation, is the Sulzer system, intended primarily to increase the overload capacity of a two-stroke-cycle Diesel. Supercharging air is furnished by a compressor, attached to the engine, under control of the engine governor; so that supercharging takes place only at the higher engine loads. Automatic valves in the upper tier of the Sulzer scavenging ports for normal scavenging and charging are supplemented by timed valves controlling the delivery of supercharging air to the cylinder, so that the latter air, furnished by the supercharging compressor, is admitted only toward the end of the charging period, that is, after the piston has covered the exhaust ports and before it covers the upper scavenging ports. With this arrangement the capacity and power consumption of the supercharging compressor are reduced to a minimum.

The capacity of an engine may temporarily be increased as much as with the Buechi system, but the fuel efficiency of the engine is adversely affected to the extent of about 5 per cent, due to the power consumed by the supercharging pump even when not in action. However, it is inexpensive to increase the peak capacity of an engine when available space does not permit the installation of a larger engine.

Still another system of supercharging has been applied to certain German four-stroke-cycle engines, for the same purposes as accomplished by the Sulzer system. In this system, also, the supercharging air is furnished by a compressor attached to the engine. In addition to the normal admission valve, a timed supplementary piston valve admits atmospheric air to the admission valve during the earlier portion of the suction stroke and supercharging air during the later portion. This, as in the Sulzer system, reduces the dimensions and power consumption of the charging compressor below what they would be if all of the charging air were furnished by it. But the German system, too, increases the fuel consumption at all loads.

As in the Buechi system, the compression and air excess in the Sulzer and German supercharged engines are adjusted so that the combustion temperatures will be substantially the same as in an engine not supercharged.

The process of scavenging, that is, clearing the cylinder of the products of the previous combustion, has a close relationship to supercharging, and is receiving considerable attention.

In the scavenging of a four-stroke-cycle engine, when the exhaust valve is opened, the major portion of the products of combustion are expelled from the cylinder by their expansion, and the remainder is pushed out by the piston. This necessitates opening the exhaust valve against the terminal pressure in the cylinder, about 35 lb., requiring a strong valve gearing. Attempts have been made to reduce this work by providing exhaust ports, uncovered by the piston near its outer dead center; but the complication of this construction has not been justified by its advantages. A recent invention provides a smaller relief valve, within, and opening in advance of, the main exhaust valve; but it is almost certain that this will not be practicable.

The simplest arrangement has been most generally adopted, piston-controlled ports for the scavenging air around one half of the cylinder circumference, and the same for the exhaust around the opposite half; but in at least one construction the scavenging and exhaust ports alternate around the whole circumference. Usually the exhaust ports are first uncovered by the piston, and the scavenging ports somewhat later, the interval being sufficient to allow the pressure in the cylinder to fall below that of the scavenging air. This arrangement affords the least time for charging, and under certain conditions allows exhaust gases to blow back into the cylinder.

*Abstract of paper presented before the Washington, D. C. Section, American Society of Mechanical Engineers, May 8, 1930.

Results of Tests on Welded Drums

Given at Boiler Inspectors' Meeting

Members favorably impressed by tests run at the Hedges - Walsh - Weidner plant of the Combustion Engineering Corporation, where pressures up to 3,450 lb. per square inch were reached without rupture of the welded boiler shell.

▼

A SYMPOSIUM on welded boiler drums as compared with drums fabricated by riveting and the presentation of new test data were the outstanding features of the eighth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held at Chattanooga, Tenn., from June 17 to 19. The symposium was based on the "Proposed Specifications for Fusion Welding of Drums or Shells of Power Boilers," which were published by the Boiler Code Committee in the March, 1930, number of *Mechanical Engineering*. The symposium was opened by a short statement by C. W. Obert, concerning the reasons for developing the specifications, and including the salient points of difference between requirements therein and other predominant methods of codifying welded pressure vessel construction. Three other speakers argued in favor of such welded construction, but offered constructive criticisms on the specifications as drafted; and two speakers took the conservative side of the question and offered objections to the permission of welded construction under such a set of specifications. The controversial features thus brought out led to a spirited discussion among the various inspectors, which was instrumental in showing clearly the trend of their opinion. A great deal of valuable information was brought out, which will undoubtedly be of assistance to the Boiler Code Committee in bringing the specifications to a conclusion.

Pressure Test Made

Following the symposium, the entire group of members and guests was given an opportunity to visit the combined plants of the Walsh & Weidner Boiler Company and the Casey-Hedges Company, which are now a unit of International Combustion Engineering Corporation. The party there saw boiler and tank construction of the heaviest order. Large, seamless, forged-steel drums and also water-wall headers were observed under construction for what will be the largest boiler unit in the world when installed at the River Rouge plant of the Ford Motor Company.

At the Hedges-Walsh-Weidner plant it was announced that experiments were being conducted with welded boiler drum construction, and that one specimen drum had been tested to destruction. While the visitors were present, another welded drum of the same size and general characteristics was tested. The following test data were taken on this drum:

Inside diameter of drum	34 in.
Length of drum between head seams	72 in.
Over-all length of drum	98 in. approx.
Shell plate thickness	1 in.
Head thickness (unreinforced)	2¼ in.
Head thickness (reinforced)	1¼ in.
Manhole reinforcement dimension	1⅛ in. th. x 27 in. O.D.
Nozzle reinforcement dimension	1⅛ in. th. x 20 in. O.D.
Nozzle dimension (inside diameter)	7⅛ in.
Nozzle dimension (wall thickness)	¾ in.
Plate and heads of firebox steel	55,000 to 65,000 lb. T.S.

Test samples of a longitudinal weld seam, made and tested under A.S.M.E. proposed specifications, gave the following results: Bent test, 60 per cent elongation of outside fibers; pull test, No. 1 sample, 61,000 lb. per square inch; No. 2 sample, 61,700 lb. per square inch.

Working pressure allowed, assuming 80 per cent efficiency for weld joint:

	Lb. Per Sq.In.
Shell	518
2¼-in. manhole head	760
1¾-in. manhole head (unreinforced)	422
Fatigue-test pressure, 10,000 cycles, varying from	0 to 778

To obtain deformation curves that would show the elastic limit, pressures were run up by 500-lb. increments, and until definite signs of yielding were observed, readings were taken of many critical points on the shell and heads by strain gages. At a pressure of 2,000 lb. the first flaking of the whitewash on the tank was noticed at the unreinforced head; at 2,300 lb. flaking was observed on the reinforced head; at 2,500 lb. definite flaking was observed at the base of the nozzle and also on the shell plate near the joint with the reinforced head. From that point on the tank showed continued deformation, both the heads and the central portion of the shell bulging very noticeably.

At a pressure of nearly 3,000 lb. leakage became noticeable at certain points, but principally at a tapped opening in the shell where connection was made to the pressure gage. Stretching of the shell continued until at about 3,450 lb. the leakage around the pressure gage tap was so great that no further increase in pressure could be obtained, and the test was discontinued. This corresponded to a fiber stress of about 60,000 lb. per square inch in the shell if computed on the original diameter, but when computed on the increased diameter (about 4 in.) amounted to nearly 63,000 lb. per square inch.

The drum previously tested, which was on exhibition in the yard of the Walsh & Weidner plant, was unreinforced at the heads. It was of the same general dimensions as the other vessel, except that both heads were 1½ in. in thickness, one being a plain head and the other having a flanged-in manhole opening. The record of its test showed that the hydrostatic pressure had run up to 3,250 lb. per square inch without rupture of the shell. The test ended at that pressure, however, because the deformation of the manhead became so great that the leakage around the manhole plate exceeded the capacity of the hydrostatic pressure pump. At this pressure, however, the cylindrical shell had increased in circumference from 109 in. to 123 in., and the fiber stress developed at this pressure was 62,800 lb. per square inch.

Approve Welded Drums

At the closing session there were interesting expressions of opinion concerning the symposium on welded boiler drums that was held on the previous day. Some members of the national board who had been averse to welded construction in the past, indicated their willingness to accept welded boiler drums if manufactured under the terms of such a set of specifications as had been discussed on the day before. The discussion indicated that over half of the inspectors present were of the same general opinion. But the rest expressed uncertainty and doubt about the acceptability of welded construction for boiler drums. The national board recorded its confidence in the work of the Boiler Code Committee, in the form of a resolution expressing its interest in the specifications submitted and urging that the committee continue its studies along that line.

At the final session invitations were extended to hold the next annual meeting in Philadelphia and Detroit.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Stoker for Firebox Boilers

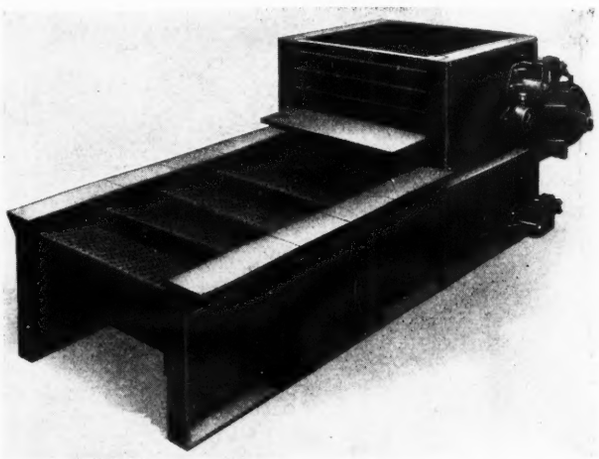
A LOW-SET model stoker for application to firebox boilers, either of the all-steel or cast-iron type, has been developed by the Whiting Corporation, Harvey, Ill. Known as Model C, the new stoker has the same general design as, but differs considerably in detail from, the Model A stoker manufactured by the same company.

As the furnace space in firebox boilers is entirely surrounded by cold walls, a reasonable amount of firebrick construction has been introduced around the fuel bed, this brickwork usually taking the form of an arch built up from the nose of the bridge wall at an angle of 45 deg. toward the front. As the gas must pass around the front of this arch, the length of gas travel is increased, and better mixing of the gases, from all parts of the fire and the combustion air, is obtained

As in the earlier model, the stoker is made up of four grate sections, each having a number of grate bars to provide air space. The feed hopper and the feed plates are indicated in the drawing by *A*. The feed plate is a combustion section, as it forms the bottom of the coal hopper as well as the first of the four grate sections. The rear end of the grate bar rests and slides upon the stationary grate *B*, which, in turn, rests upon grate *C*. Being movable, the third grate section rests and slides upon grate *D* and at the same time slides back and forth under section *B*.

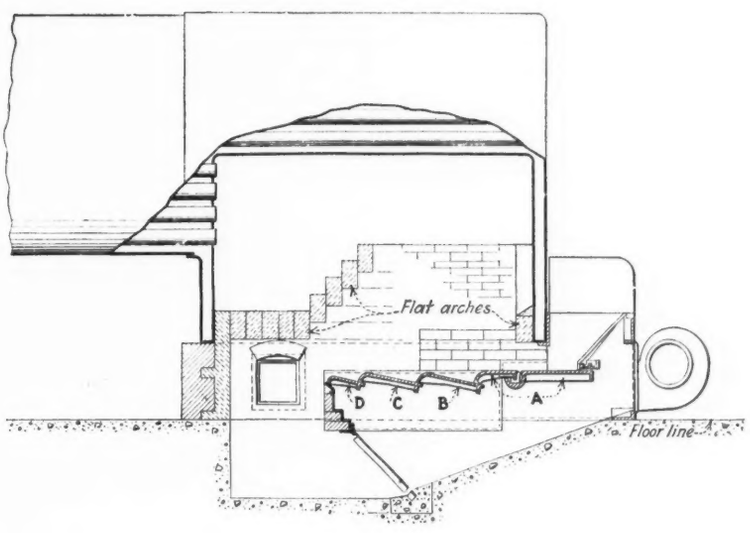
As will be seen, the movable sections, which are supported on roller bearings, have a reciprocating action that feeds the coal from the hopper and advances the fuel bed. The backward and forward motion of sections *A* and *C* affords a uniform feed. The movement of the grate is adjustable from 1 to 4 inches. Motive power consists of a motor mounted on the front door of the stoker, together with a fan and a reducing gear.

Model C stoker is only 14 in. from the floor to the top of the ledge, making it possible to put it under firebox boilers set in their usual low position. The unit is designed to handle any bituminous coal, and is featured by its constant removal of ash.



Left—Model C low-set stoker

Below — Section through furnace of firebox boiler showing arrangement of grate section and brickwork used in the furnace



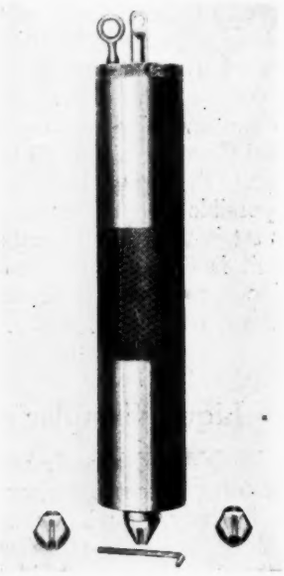
Liquid Sampler

TO PROVIDE a ready means of obtaining a composite sample of practically any liquid, or samples from three levels of tanks or tank cars, the liquid sampler illustrated has been introduced by the Hills-McCanna Company, 2349 Nelson St., Chicago, Ill.

The sampler operates on the single plunger suction principle. It consists of a hollow metal cylinder 13½ in. in length, made of non-sparking metal. A close-fitting piston, without packing, operates within the cylinder. Interchangeable nozzles for handling

liquids of varied viscosity are provided for the outlet in the lower end of the cylinder.

To operate, the sampler is lowered into the tank or vessel to the desired depth by means of a length of chain attached to its upper end. A second length is fastened to the plunger rod. This rod is notched at three equidistant points, dividing the cylinder into three parts of equal capacity. Liquid is drawn into the lower third of the chamber by pulling the chain attached to the plunger. The sampler is then raised to a second and a third



Sampler with interchangeable nozzles

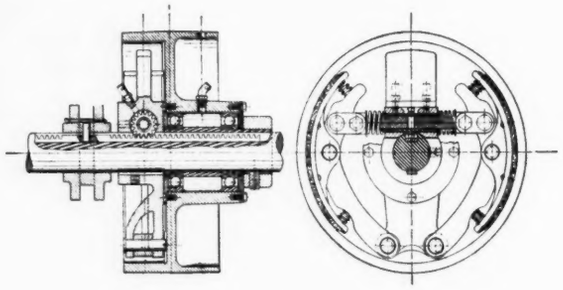
position, where successive samples are obtained in the same manner, filling the sampler to its full capacity of 32 ounces. The operator is informed when each portion is filled by contact of a notch in the plunger rod with a spring ball set in the cylinder neck.

Clutch With Self-Equalizing Friction Shoes

IN THE Oct. 8, 1929, number a friction clutch put out by the Duro-Friction Clutch Company, Grand Rapids, Mich. was illustrated and described. This company has recently brought out a design of clutch that embodies a number of new features.

Referring to the illustration, the clutch is equipped with friction shoes, so hinged and mounted that they automatically take care of any wear. The expansion units are made up of right- and left-hand studs which screw into the hub of a spur gear. When a rack mounted in a slot in the shaft is moved in one direction the gear revolves and forces the friction member out into contact with the pulley rim.

When all the wear is taken up by the float, of $\frac{5}{16}$ in., an adjustment can be made by taking out the link screws and making one turn of the pivot screws outward. The contact of the clutch is said to be positive, but not subject to shock.



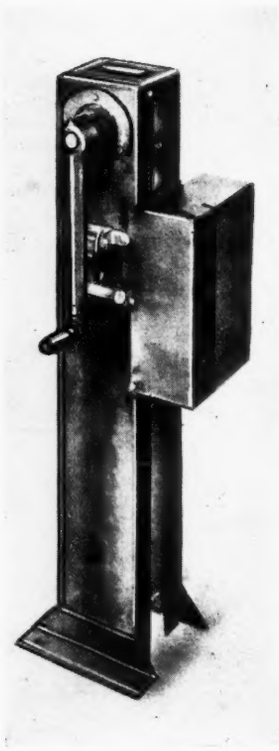
Friction shoes are mounted to give uniform wear

Pedestal for Gang-Operated Disconnecting Switches

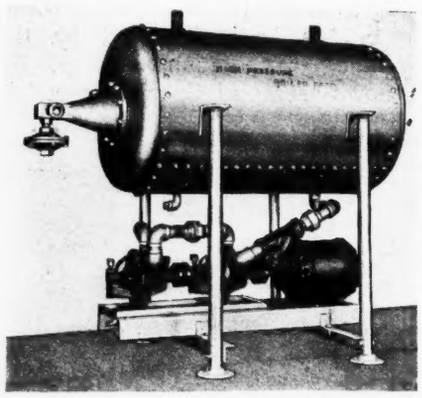
A LINE of pedestals for gang-operated heavy-duty disconnecting switches has been developed by the Champion Switch Company, Kenova, W. Va.

The vertical operating shaft at the top end has miter gears driven by a handle. The lower end has a universal joint, allowing the operating pedestal to be set over the shaft and bolted down without special aligning.

A wing extension on the shaft traveling nut acts as a positive stop in both positions, a plate indicating the switch position. Each pedestal has inclosed contacts in series with the oil-breaker operating circuit, opening this circuit unless the disconnects are in the fully open or closed position.



Operating pedestal for disconnecting switches



Boiler feed unit with two pumps connected in series

Automatic Boiler-Feed Unit

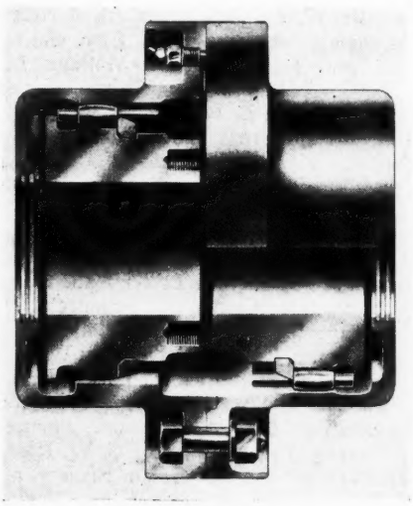
DESIGNED to supply either high- or low-pressure boilers with feed water, or to return condensate to the boiler and supply make-up as required, the automatic boiler feed unit now being put out by Mears-Kane-Ofeldt, Inc., 1903 East Hagert St., Philadelphia, Pa., is available in a number of sizes suitable for use with heating and the smaller industrial boilers.

The unit illustrated consists of a tank or receiver equipped with a make-up water control valve and mounted above a motor-driven pumping unit comprising two centrifugal pumps connected in series. The pumps draw their water supply from the tank, which is vented to the atmosphere and into which all the condensation is discharged by return-line

pumps or traps and to which the make-up water is supplied if required by a float-type feed-water regulator built into one end of the tank.

Automatic operation of the pumping unit is effected by an electric switch mounted on a float chamber attached to the boiler with which the feeder is used. This method of control, it is claimed, permits of holding the water level limits within $\frac{1}{2}$ inch.

Style 23T unit, illustrated, is equipped with a 30-gal. receiver, and the approximate dimensions of the unit are 46x30x37 in. Units are also available with a single pump and with two pumps connected in parallel.



Sectional view of coupling

Improved Flexible Coupling

IN THE flexible coupling illustrated, designated T.Q.E. (Thomas quadruple engagement), developed by C. O. Thomas, 91 Grand Boulevard, Montreal, Quebec, a floating casing forms a connection between two hubs each keyed to a shaft, near its ends. The casing has inwardly facing flanges machined to a cylindrical bore, which are a close sliding fit on the spherically curved perimeter of outwardly facing flanges on each of the hubs. Driving connection between the hubs and casing is afforded by barrel-shaped pins fitted in holes bored half their diameter in the hub flanges and half in the casing flanges. The longitudinal radius of curvature of the pins is concentric with the spherical formation of the hub flanges.

Relative movement between the hubs and floating casing is confined to the spherical part of the hubs and the outer semi-circumferential surface of the pins. These surfaces, being nearly at the largest diameter of the casing, are subjected to the greatest centrifugal oil pressure and are effectively lubricated when the coupling is in service.

For aligning the shaft, each half of the casing is moved back and centered upon its hub to become coaxial with the shaft center line. A straight edge is then laid across the flanges of the casing.

Among the claims made for the coupling are that it permits of a large eccentricity or parallel misalignment of shafts, approximately $\frac{3}{32}$ in. in the 2-in. shaft size and $\frac{1}{4}$ in. in the 12-in. shaft size with a clearance in the pin holes of less than 0.001 inch.

In addition to steam turbines and motor drives, the coupling is especially suitable for machines in which backlash is a disadvantage, and in reversing service.

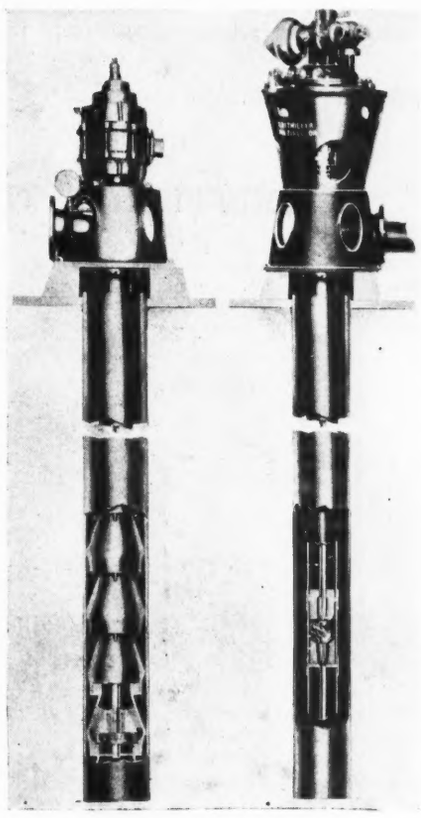
Turbine- and Screw-Type Deep-Well Pumps

TO THE LINE of deep-well piston pumps, triplex pressure pumps and hydro-pneumatic systems put out by the Luitwieler Pumping Engine Company, 123 Ames St., Rochester, N. Y., has been added the "Multipellor" turbine pump, direct-flow type, and the screw-type direct-flow unit illustrated.

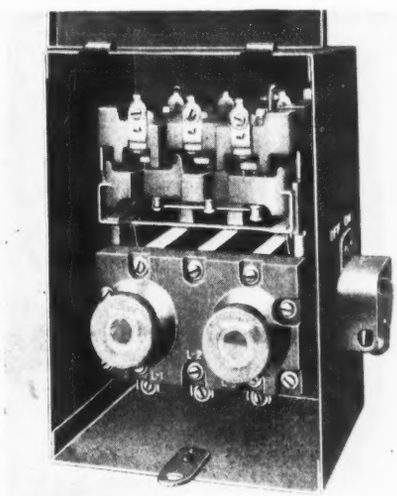
An outstanding feature of the new pumps is the use of special laminated bearings of resilient material, which, it is claimed, requires no lubrication whatsoever. This is a particular advantage inasmuch as the working parts are located at intervals along the shaft or at different heights in the casing. The shaft carrying the impellers and water load rotates on, and is carried by, two annular thrust bearings built into the motor or pump head.

The special design of bearings requiring no lubrication on the pump shaft, precludes possibility of contaminating the water with oil and lessens danger of injury to the pump when handling sand-laden water.

In addition to the motor- and turbine-driven heads shown, a head suitable for belt drive from engine or line shaft can be furnished.



Turbine- and screw-type pumps



Manually operated motor starter with air-break contacts

Motor Starter With Air-Break Contacts

A NEW manually operated motor starter with air-break contacts recently brought out by the Condit Electrical Manufacturing Corporation, Boston, Mass., is illustrated.

In the starter, which is known as type A-15, the contacts are assembled in units on insulated carrier bases, one stationary and the other movable. The movable contact base can be withdrawn without the use of tools, permitting of ready inspection of both movable and stationary contacts, which are identical and interchangeable. Thermal cutouts are provided for time-lag overload protection.

The unit illustrated is furnished for $7\frac{1}{2}$ hp. at 550 and 440 volts, 5 hp. at 220 volts, and 3 hp. at 110 volts.

NEWS of the FIELD

▼

Spot News

•

UNDAUNTED *by the loss, reported in this column July 1, of the giant power pipe which was to convey cold water from the depths of the Gulf Stream near Cuba in his scheme for extracting energy from the difference of temperature between the surface and bottom of the ocean, Prof. Georges Claude has announced that another pipe will be ready for installation in August.*

•

ERECTION *of Boulder Dam has begun, Secretary of the Interior Wilbur announced in a statement July 7. The order for construction on the $165,000,000 project was signed by Mr. Wilbur following the approval by President Hoover on July 3 of the second deficiency bill containing the initial appropriation of $10,660,000. Plans and specifications for the awarding of construction contracts are being carried to completion with all possible speed, according to the Secretary.*

•

THE INJUNCTION SUIT *filed against the Union Electric Light & Power Company of St. Louis, as reported in Power of May 27, to prevent further construction of the company's $30,000,000 hydro-electric development on the Osage River near Bagnell, Mo., has been refused in the United States Circuit Court at Kansas City.*

•

IN AN OPINION *rendered to President Hoover, on questions submitted by the Federal Power Commission with reference to the application of the Cumberland Hydro-Electric Power Company for a license to construct a project in the vicinity of Cumberland Falls, Ky., the United States Attorney General holds that the commission has no power to refuse a license for the erection of the dam because it would interfere with scenic or recreational facilities.*

Model of Original Niagara Falls Plant Proposed for Chicago World's Fair

A REPRODUCTION of the original Niagara Falls power plant, a model of which now stands in a field adjacent to the old Niagara Falls Power Company's stations 1 and 2, has been proposed as one of many exhibits to be staged at the Chicago World's Fair in 1933 to show the advances that have been made during the last hundred years in mechanical engineering.

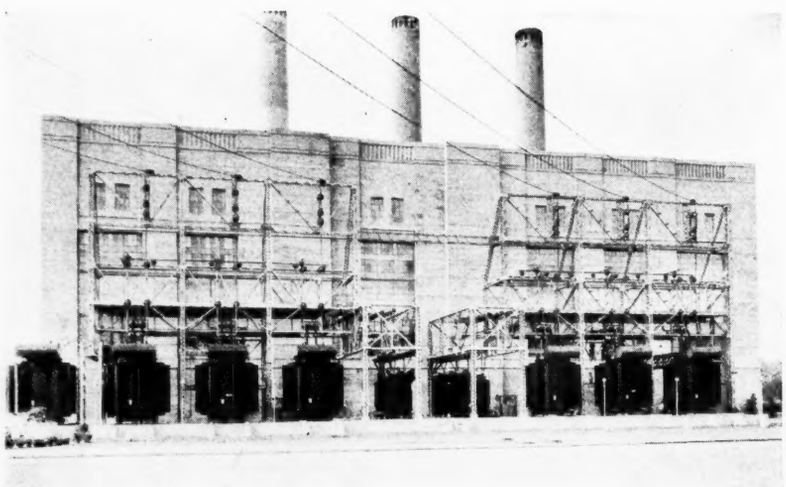
The recommendation that a replica of the Niagara Falls model be erected at Chicago is contained in a report of the mechanical engineering section of the National Research Council Science Advisory Committee, under the direction of which all the mechanical engineering displays will be exhibited at the exposition.

According to the report of the mechanical engineering section the fair exhibits to be staged under its direction will include the following subdivisions: power and power generation, applied mechanics, hydraulic machinery, printing machinery, materials handling, management in industry, machine shop and manufacturing processes, machinery in the iron and steel industry, aerodynamics, refrigeration, air conditioning, heating and ventilation.

The mechanical engineering section includes W. L. Batt, president of SKF Industries, Inc., New York City, chairman, and the following: William L. Abbott, Commonwealth Edison Company, Chicago; L. P. Alford, vice-president, Ronald Press, New York; K. H. Condit, *American Machinist*, New York; Prof. R. H. Fernald, University of Pennsylvania; Clarence F. Hirshfeld, Detroit Edison Company; George A. Horne, Merchant Refrigerating Company, New York; A. L. Kimball, General Electric Company, Schenectady; Dean Dexter S. Kimball, College of Engineering, Cornell University; W. W. Macon, *Iron Age*, New York; J. C. Oswald, New York Employing Printer's Association; Dean A. A. Potter, Purdue University, Lafayette, Ind.; C. W. Rice, secretary of the American Society of Mechanical Engineers, New York; W. A. Shoudy, New York, and R. V. Wright, secretary, Simmons-Boardman Publishing Company, New York.

▼ ▼ ▼

SHUFFLETON'S TRANSFORMER BANK



Seven Westinghouse 16,667-kva., 55,000-volt transformers and five Westinghouse 1,500-kva., 13,800- to 2,300-volt transformers are installed on this bank at the Shuffleton Steam Plant of the Puget Sound Power & Light Company at Renton, Wash.

Largest Flywheel Motor-Generator Set Ordered

The largest flywheel motor-generator set on record has recently been sold by the Westinghouse Electric & Manufacturing Company to the Illinois Steel Company for use in a new 44-in. reversing universal slabbing mill. This set has a continuous rating of 10,500 kw. at 700 volts, and will carry peak loads of approximately 40,000 amp. The set consists of three 3,500-kw., 700-volt direct-current generators coupled to a 6,500-hp., 25-cycle, induction motor with a 180,000-lb. flywheel, 15 ft. in diameter. The over-all length is about 60 ft. and the total weight of the set, including the flywheel, will be 600,000 pounds.

A unique feature of this application is that all three generators will be operated in parallel by cross-connected differential and cumulative compound series fields. The generators will supply power to two 5,000-hp. double-armature reversing motors, making a 10,000-hp. twin drive for the horizontal rolls, and a 2,500-hp. single-armature reversing motor for the vertical rolls.

Another item of interest is that the motor-generator set and motors will be installed in a substation using a closed recirculating ventilation system, which will require 220,000 cu.ft. of air per minute. It will require a cooler capable of dissipating 1,800 kilowatts.

PREPARING TO HARNESS 57,000 HP.

At the Schenectady works of the General Electric Company the brake plates are being faced on the rotor spider of one of the largest hydro-electric generators ever built. The electrical capacity of this machine, when completely assembled and in operation at the Spier Falls station of the New York Power & Light Corporation, will be 47,000 kva. Second only to the generators at Niagara Falls in output of electrical energy, it stands first in over-all diameter, measuring 43 ft. across

▼ ▼ ▼

Ohio Merger Approved

Consolidation of five public utility companies into a new corporation to be known as the Ohio Edison Company, with a property and investment value of more than $100,000,000, has been approved by the Ohio Public Utilities Commission, in an order just issued. The consolidating companies are the Pennsylvania-Ohio Power & Light Company, of Youngstown; the Northern Ohio Power & Light Company, of Akron; the Ohio Edison Company, of Springfield; the London Light & Power Company, of London; and the Akron Steam Heating Company, of Akron.

Sunday Law Revived to Keep Out Utility

Seventeen employees of the Florida Power Corporation were arrested at Gainesville, Fla., by deputy sheriffs on charges of violating a state law passed in 1854 which prohibits work on Sunday. The arrests followed injunction proceedings instituted by the city attorney restraining the corporation from construction of lines or distribution of electric current within the city limits of Gainesville. The city attorney previously had applied for an injunction to restrain the corporation from serving the University of Florida, much of which is within the city limits, on the claim that the city charter gives the city authority to furnish any and all local public service within the city limits of Gainesville.

No License on Priest Rapids

As the Washington Irrigation & Development Company was unable to establish, prior to July 1, that it would be able to find a market for enough power to justify the installation of 200,000 hp. at Priest Rapids, on the Columbia River, the Federal Power Commission has rejected the application of the company for another license. Studies made in connection with the project convince members of the commission's staff that further development of the country in the Priest Rapids region must take place before it can support a project of the size that necessarily must be built to harness the Columbia at that point.

Prize for Diesel Paper

The Diesel Engine Users Association, of England, has decided to offer a prize for a paper contributed during 1931. The prize, a medal and 25 guineas, will be awarded for the best paper of the year considered to be of the greatest value to the Diesel engine user. The award will not be restricted to members of the association.

News of Canada

Saskatchewan plans development of large power system—Buckingham Power Company formed — Central heating plant for Winnipeg

ELABORATE PLANS for power development are being laid by the government in the Province of Saskatchewan. While the Power Commission's program is at present confined to steam plant production, the question of development of the Saskatchewan River is receiving serious consideration and investigations are now in progress.

The commission has in hand a $2,500,000 power scheme to link between 60 and 65 towns and villages. For the most part this will supply services in northern areas. In this connection the commission controls the municipal steam plant at Saskatoon, which will serve as the base and supply point for a considerable part of its system. About 650 miles of high-tension power lines are now under construction. The municipal plants involved in the circuit are said to have sufficient power available to meet the requirements.

QUEBEC incorporation papers have just been taken out by the Buchingham Power Company, an organization formed to take over the hydro-electric develop-

ment of the Maclaren interests on the Lievre River. Considerable progress has been made by the company in connection with its water-power development, and it will likely take over the James Maclaren 15,000-hp. development at Buckingham, which is being increased to 25,000 horsepower.

The big project, however, is taking place at Masson, where a further 100,000 hp. is being developed. It is proposed to equip the power house with an initial installation of three units of 30,000-hp. each, with provision for a fourth unit later on. Construction of the power house will cost approximately $5,000,000, while a storage dam some miles up the Lievre River will involve a further outlay of $1,500,000. The two developments are expected to be completed by the spring of 1931.

CONSTRUCTION of a $2,000,000 steam heating plant on the outskirts of the city of Winnipeg by the Northern Engineering & Development Company has been approved by the city council. Subject to approval of the building commissioner, construction of the big central heating plant will commence as soon as possible. The Northern Engineering & Development Company has held a franchise from the city since April, 1929.

▼

Obituary

WILLIAM NEWTON RYERSON, president of the Trojan Engineering Corporation of New York City, died July 7 at his home in that city after an illness of six weeks. He was 56. Mr. Ryerson was born in New York and was educated at the Columbia University School of Mines, finishing in 1896 and then specializing in electrical engineering. After a number of years' association with power companies in different parts of the United States he became head of the Trojan organization in 1928. He was a member of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers.

FREDERICK SHERMAN HICKOK died June 20, at his home in Berwyn, Ill., after an illness of about six months' duration. Mr. Hickok was born in Pottsdam, N. Y., in 1869, and after graduation from Tufts College went to Chicago in 1890 and was engaged by the Western Electric Company, with whom he was employed until about 1907, when he became Chicago representative for the Ridgway Dynamo & Engine Company. He held this position until that firm was taken over by the Elliott Company about three years ago. Since that time he had been connected with C. M. Garland & Company, Chicago consulting engineers, in the capacity of business representative. Mr. Hickok was well known in and around Chicago for his business and engineering ability.

▼

How's Business?

DEVELOPMENTS of the past week strengthen the conviction that a period of stabilization has set in, in preparation for the process of business recovery. Nothing has occurred to alter the view expressed in last week's issue that this process will become evident, even through blue glasses, at the beginning of August. . . . Our preliminary index of general business activity for this week, with one component estimated, has risen further, from 93.9 per cent of normal to 95.2 per cent. Occasional downward fluctuations may be expected from time to time in the next few weeks, but a return to the low level of the middle of June is unlikely. . . . The general trade indicators as a group have risen sharply, and are within two per cent of normal, while productive activity remains considerably below normal. Commercial loans are increasing with seasonal demand, and the general rate of credit expansion continues considerably above normal and rising steadily. The rate of commodity price decline is below the average of the past year, and in some key markets greater steadiness has appeared. —*The Business Week* July 9.

▼

To Start Construction on Denver-Valmont Line

The Public Service Company of Colorado, Denver, will begin construction immediately on a 100-kv. transmission system connecting Denver with its Valmont steam generating plant near Boulder, Colo. The new line will connect with other 100-kv. lines at Valmont and will supply a part of the Denver load through the company's North Denver substation. Upward of half a million dollars is to be spent on the system, materials for which have already been ordered.

Wood frame construction, such as has been found satisfactory on the Leadville-Gilman transmission line, where lightning is a serious factor, is to be used from the Denver city limits to Valmont, with 266,000 circ.mil steel-cored aluminum wire.

Among other items to be installed will be a bank of three air-cooled transformers for North Denver substation. This bank is to have a rated capacity of 25,000 kva., with provision for 50 per cent overload when transformers are cooled with an air blast.

Personals

HERBERT L. SEWARD, professor of mechanical engineering at Yale University, was recently appointed Robert Higgin professor of mechanical engineering at the university. Professor Seward is widely known for his work on the Fuel Conservation Committee of the United States Shipping Board. He has rendered important service in the development of marine power machinery and has become one of the leading authorities in this field.

A. L. POLLARD has been appointed superintendent of the steam division of the Puget Sound Power & Light Company, Seattle, Wash., reporting to John Harrisberger, general superintendent of power. Mr. Pollard has had a wide experience in power plant work with the Stone and Webster organization.

WILLIAM W. ODELL, who was connected with the United States Bureau of Mines for a period of twelve years in the capacity of gas and fuels engineer, has joined the staff of the Columbia Engineering and Management Corporation of New York City. GEORGE T. KOCH, formerly assistant superintendent of compressor stations for the company, has been promoted to superintendent of compressor stations.

CARL STRIPE, publicity director of the Combustion Engineering Corporation, was elected chairman of the Exhibitors Committee of the Power Show at its recent annual meeting. This committee was organized in 1926 for the purpose of investigating the merits of various power shows. Other officers elected were: VICTOR WICHUM, chief engineer of the Tagliabue Manufacturing Company, vice-chairman; W. W. BERTRAM, of the Morse Chain Company, secretary; and J. P. FERGUSON, of the Reading Steel Casting Company, treasurer.

S. M. DEAN has been appointed chief assistant superintendent of electrical system of the Detroit Edison Company. Other appointments in the company include R. E. GREENE as senior engineer of the engineering division and HAROLD B. TYREE, as supervising engineer of the research department.

R. A. WHITNEY, formerly construction engineer of the Public Service Company of Northern Illinois, has been appointed to the newly created position of building engineer. H. C. KALWITZ, formerly assistant construction engineer, has been made construction engineer to succeed Mr. Whitney.

JOHN T. BRODERICK, for the past 36 years secretary of the General Electric Company's manufacturing committee, retired from active service July 1. Mr. Broderick concludes 41 years of continuous service wth the company, having started with the old Thomson-Houston Company in 1889.

Business Notes

TUBE-TURNS, INC., Louisville, Ky., announces an extension to its plant and equipment which will increase production by 60 per cent. Construction of the addition to the factory was completed July 1, and the new equipment will be ready for operation by Aug. 1. Sales of the company for the first five months of this year were 271 per cent more than during the corresponding period of last year, according to the announcement.

GENERAL INSULATING & MANUFACTURING COMPANY, Alexandria, Ind., announces the establishment of a New York office at 370 Lexington Avenue, with William C. Hyatt in charge as district and export manager.

GAS COMBUSTION COMPANY and DUQUESNE BURNER SERVICE COMPANY have joined the Swindell-Dressler Corporation, with offices and plant at Pittsburgh, Pa.; address is P. O. Box 1753. The other companies in the consolidation are WILLIAM SWINDELL & BROTHERS and AMERICAN DRESSLER TUNNEL KILNS, INC.

THE H. K. FERGUSON COMPANY, Cleveland, Ohio, announces the acquisition of the business, assets and goodwill of WARREN D. SPENGLER, INC., consulting power plant engineers of Cleveland. The personnels of both companies remain the same as before the merger.

BRADFORD PUMP MANUFACTURING COMPANY, San Jose, Calif., announces the appointment of Eck L. Baughn as sales manager. Mr. Baughn was formerly San Francisco district manager of the Byron Jackson Pump Company.

DAVIS REGULATOR COMPANY, Chicago, Ill., recently moved into its new factory located at 2541 South Washtenaw Avenue. Erection of the new plant was made necessary by the expansion of manufacturing departments and the desire of the company to increase production facilities for future operations. The company has changed its name from G. M. Davis Regulator Company to the above.

WHITING CORPORATION, Harvey, Ill., announces that the Goslin-Birmingham Manufacturing Company of Birmingham, Ala., has become affiliated with it.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., announces the addition of Herbert Hoover to its Philadelphia branch sales office. Mr. Hoover was formerly general distribution engineer for the Potomac Electric Power Company. Announcement is also made of the appointment of H. W. Petty as branch sales manager for the Pittsburgh territory with office in Pittsburgh, Pa. Mr. Petty has been serving as salesman in the Detroit territory.

▼

COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual Pacific Coast convention at Portland, Ore., Sept. 2-5. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

▼

Trade Catalogs

BURNERS—A new bulletin, No. 306, covering atmospheric gas burners for boilers has just been printed by the Denver Fire Clay Company, P. O. Box 1107, Denver, Colorado.

GRINDING WHEELS—A selection of advertisements of the Norton Company, Worcester, Mass., has been reproduced in booklet form illustrating and explaining various Norton products.

GAGES—The Ellison Draft Gage Company, 214 West Kinzie St., Chicago, Ill., has issued Bulletin 9-A on draft gages of the tube type.

CONVEYORS—A new conveyor catalog has just been published by the Palmer-Bee Company, Detroit, Michigan. This contains close-up photographs of installations and full-size details of construction.

TERMINATORS—The Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., is distributing its Bulletin No. 65-A, describing new type "PB" cable terminators for service up to 750 volts. These terminators are for use with low-voltage lead-covered or braided cables.

WELDING—The most recent of the series of publications sent out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., are Nos. 12 and 13 on the latest developments in the arc-welding field and news of interest to designers and users of welding and welded products.

INSTRUMENTS—The Brown Instrument Company, Wayne and Roberts Aves., Philadelphia, Pa., has just issued a revised edition of "Electric Flow Meter Instruction Book." This 40-page, fully illustrated booklet explains the mechanism of the various types of Brown flow manometers, indicators and recording instruments, gives instructions for installing the equipment, adjusting for zero readings, and changing range tubes. Practical suggestions for avoiding difficulties are given, and tables of correction factors for pressure, quality, and superheat are included.

▼

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.25 @$2.50
Kanawha	Cincinnati	1.15 @ 1.35
Smokeless	Cincinnati	1.85 @ 2.00
Smokeless	Chicago	1.75 @ 2.00
West Kentucky	Chicago	.85 @ 1.30
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	1.10 @ 1.25
Big Seam	Birmingham	1.60 @ 1.75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$2.90 @$3.00
Barley	New York	1.15 @ 1.50

FUEL OIL

New York—July 10, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6@6.25c. per gal.

St. Louis—June 25, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.420 per bbl., or 42 gal.; 26@28 deg., $1.495 per bbl.; 28@30 deg., $1.570 per bbl.; 30@32 deg. $1.625 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., distillate, 4.98c. per gal.

Pittsburgh—July 1, f.o.b. lcoal refinery, 30@34 deg., fuel oil, 3.12½c.@3.25c. per gal.; 36@40 deg., 3.12½c.@3.5c.

Philadelphia—July 7, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati—July 8, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—July 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 75@80c. per bbl.; 26@30 deg., 85@90c. per bbl.; 30@32 deg., $0.95@$1.00 per bbl.

Boston—July 7, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.33c. per gal.; 28@32 deg., 5c. per gal.

Dallas—June 28, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Flagstaff—National Guard of Arizona, J. F. Pomeroy, Adj. Genl., Phoenix, is making preliminary plans for a permanent encampment, including power house, etc., to be known as Ft. Alexander M. Tuthill. $100,000.

Calif., Los Angeles—J. A. Wigmore & Associates, are having plans prepared for the construction of a 12 story office and 13 story hotel on 7th St. between Garland and Bixel Sts. Estimated cost $3,000,000. C. Beelman, 1019 Union Bank Bldg., is architect.

Calif., Pasadena—City is making plans for altering compressor and power house, etc., in connection with sewage disposal plant. $26,000. G. K. Hooper is city engineer.

Calif., Tehachapi—State of California plans construction of a women's state prison, including steam plant, here. Estimated cost $300,000. G. B. McDougall, Public Works Bldg., Sacramento is state architect.

Conn., Hamden—Connecticut Co., 185 Church St., New Haven, awarded contract for the construction of a 1 story, 25 x 40 ft., power substation, to National Constr. Co., 152 Temple St., New Haven. Estimated cost $40,000.

Conn., Hartford—Hartford Electric Light Co., 266 Pearl St., awarded contract for the construction of a power substation at Market St., to Industrial Construction Co., 721 Main St. $29,500. Estimated cost including equipment, $40,000; also having plans prepared for a substation on Park St. Cost to exceed $40,000. W. T. Marchant, 36 Pearl St., is engineer.

Kan., Abilene—City, M. E. Calkins, City Clerk, City Hall, will receive bids until July 22, for sewage disposal plant, including pumping and sludge heating equipment. Black & Veatch 700 Mutual Bldg., Kansas City, Mo. are engineers.

Mass., Quincy — Miller & Levi, Archts., 46 Cornhill, Boston, receiving bids for the construction of a 1 story, 75 x 130 ft. boiler plant and agency building at Federal St. Estimated cost $50,000. Owners name is withheld.

Mass., Springfield—Springfield Hospital, 759 Chestnut St., having revised plans prepared 7 story, 60 x 200 ft., hospital addition and 2 story, 50 x 240 ft., service building, North Chestnut and Springfield Sts. Estimated cost $1,000,000. Stevens & Lee, 45 Newbury St., Boston, are architects.

Mass., Woburn—C. A. Carlson, 399 Washington St., awarded contract for the construction of a greenhouse and boiler house, to King Constr. Co., 25 Huntington Ave., Boston. Estimated cost $25,000.

Mich., Detroit—Public Lighting Comn., 174 East Atwater St., awarded contract for the construction of an extension to substation at Joy Road, to Lendzon Constr. Co., 5765 Chene St. $26,648.

Mo., St. Louis—St. Louis University, c/o A. Schwitalla, S. J., Dean School of Medicine, 1402 South Grand Blvd., having plans prepared for the construction of the Firmin Desloge Hospital on Grand Blvd. between Vista and Rutgers Sts. Estimated cost $1,000,000. Study & Farrar, 363 Arcade Bldg., are architects and A. J. Widmer, 1217 Fullerton Bldg., is associate architect.

N. J., Jersey City—Bd. of Commissioners, City Hall, received lowest bid for the construction of power house, including mechanical equipment, and boilers for the Jersey City Hospital, from John H. Cooney, Inc., 210 North 4th St., Harrison, $268,542.

N. J., Perth Amboy—Warner Bros. Theatres, Inc., H. M. Warner, Pres., 321 West 44th St., New York, will receive bids until about Aug. 1, for a 2 story, basement, 105 x 260 ft. theatre, including ventilation, steam heating system, etc. Maple St. Estimated cost $1,000,000. J. Eberson, 370 Lexington Ave., New York, is architect.

N. J., Secaucus — Bd. Chosen Freeholders, Court House, Jersey City, awarded general contract for the construction of a power house, boiler room and smoke stack at New Contagious Diseases Hospital, here, ti De Risko Construction Co., 921 Bergen Ave., Jersey City, $40,944; heating and equipment, to E. J. Wohrle, Tube Concourse Bldg., Jersey City, $47,200.

O., Cincinnati—Dept. of Welfare, 9th and Oak Sts., Columbus, is having plans prepared for the construction of a 84 x 105 ft. power house, 50 ft. high at Longview State Hospital here. Estimated cost $65,000. T. R. Ridley, Ohio Hartmann Bldg., Columbus, is architect.

O., Cleveland—State Dept. of Public Welfare, H. H. Griswold, Dir., Columbus, will receive bids until July 30, for the construction of a 1 story, 66 x 124 ft. cold storage, storeroom, bakery, etc. and 2 story, basement, 100 x 100 ft. laundry building and equipment, at Canal Rd. Estimated cost $150,000. L. R. Ridley, Hartman Bldg., Columbus, is architect.

O., Dayton — Schenck & Williams, Archts., 3rd National Bldg., receiving bids until late in July, for a 4 story hospital, including nurses' home, service quarters, Fairview Ave., for Good Samaritan Hospital Association. J. Q. Sherman, Chn. Dayton. Estimated cost $1,500,000.

O., Portsmouth—Ohio Power Co., will soon award contract for the construction of a 40 x 60 ft., substation, 50 ft. high, at Millbrook Park. Estimated cost $50,000. Private plans.

Okla., El Reno — City, J. H. Bender, City Manager, is making plans for the construction of light and power plant. Estimated cost $450,000.

Pa., Coraopolis—Felician Sisters, A. Menonissa, 5th Ave. Extension, McKeesport, in charge, awarded contract for the construction of a 3 story, basement, 40 x 100 ft., power house at Montour St., to W. N. Kratzer Co., 3212 Smallman St., Pittsburgh.

R. I., Melville—Bureau of Yards and Docks, A. L. Parsons, chief of bureau, Navy Dept., Wash., D. C., will soon receive bids for the construction of a power plant, at the Naval Fuel Depot, here. Spec. 6031.

Texas and New Mexico—Shell Pipe Line Corp., Shell Bldg., St. Louis, Mo., is making preliminary plans for extending pipe line from Hendrick fields in Winkler Co., Tex. to Hobbs oil field in Lea Co., N. M., including pumping stations and equipment, etc. Estimated cost $300,000. Private plans.

Tex., Lufkin—Moore Grocery Co. plans the construction of a refrigeration plant, including 6 cold storage rooms, etc., here. Estimated cost $15,000. Private plans.

Va., Overall—Page Power Co., Luray, has applied to the State Corporation Comn., Richmond, for permission to construct hydro-electric development, including dam on the south fork of the Shenandoah River, near here.

Ont., Chats Falls — Chats Falls Power Co., Montreal, Que., awarded contract for equipment for the power development, here, to Canadian Westinghouse Mfg. Co., Hamilton, $2,000,000.

Ont., Napanee—Town awarded contract for extending waterworks, including pumphouse, coagulation basin, mixing chamber, etc., to R. H. McGregor Constr. Co., Ltd., 79 Adelaide St. East, Toronto. Estimated cost $15,000.

Ont., Toronto—Hamilton Bridge Works, General Assurance Bldg., Toronto, awarded contract for construction of a power plant to include electric motors, frequency changers, etc., in connection with structural steel plant, to Anglin-Norcross, Ltd., Temple Bldg. Estimated total cost $50,000.

Ont., Toronto—Victoria & Emanuel College, Queens Park, will soon receive bids for the construction of 3 story and basement men's and women's buildings, including electric lighting, steam heating, etc., Queens Park. Estimated cost $500,000. Spratt & Ralph, 1162 Bay St., are architects.

Que., Montreal—McGill University, Sherbrook Ave., awarded contract for the construction of a steam tunnel on campus, here, to E. G. M. Cape & Co., 620 Cathcart St. $30,000.

Equipment Wanted

PUMP, MOTOR, etc.—**Boston, Mass.**—J. M. Verrill, 201 West Newton St., plans to purchase water pump, motor and tank for driven well.

BENT TUBE TYPE BOILER, etc. — **Ionia, Mich.** — State Administrative Bd., 202 State Office Bldg., Lansing, will receive bids until July 24, for furnishing and installing 300 hp. bent-type tube boiler complete with brickwork, stoker, breeching, etc. for power house for Ionia State Hospital, here. D. C. Milbourn, State Office Bldg., Lansing, is engineer.

PUMPS, MOTORS, etc.—**Greenville, Miss.**—G. Drew, City Clerk, will receive bids until July 21, for two 800 g.p.m. sewage pumps against 74 ft. head, 2 motors of rated speed and horsepower, etc. in connection with sewerage system.

BOILERS, STOKERS, etc.—**Skillman, N. J.**—Dept. of Institutions & Agencies, State Office Bldg., Trenton, rejected bids received June 20, for boilers, stokers, breechings, ash and coal handling equipment, conduits, etc., for State Village for Epileptics. Plans to be revised. Estimated cost $25,000.

DIESEL ENGINE—**Galt, Ont.**—Public Utilities Comn., A. B. Scott, Secy., furnish and install 400 to 500 hp. diesel engine in connection with waterworks system. Estimated cost $30,000. C. Cuthill, Supt. Waterworks, Galt.

Industrial Projects

Calif., Oakland — Margaret Burnham Candy Co., 3800 Piedmont Ave., is completing plans for the construction of a 2 story candy factory, 46th Ave. and Telegraph St. G. Koster, 2355 Leavenworth St., San Francisco is architect.

Calif., Ontario—Edison Appliance Co., Ontario, plans the construction of an addition to plant also equipment for the manufacture of electric ranges. Estimated cost $1,000,000.

Calif., Pittsburg—Shell Chemical Co., (subsidiary of Shell Oil Co.,) Shell Bldg., San Francisco, awarded contract for the construction of the first units of chemical plant on 613 acre site, to G. Wagner, Inc., 181 South Park, San Francisco. Estimated cost $5,000,000.

Calif., Redwood City—Pacific Gas & Electric Co., 245 Market St., San Francisco, making plans for the construction of service buildings, including warehouse, machine shop, cross-arm paint plant, garage. Estimated cost $40,000. Private plans.

Conn., New Haven—National Folding Box Co., James St., awarded contract for the construction of brick addition to factory for the manufacture of folding boxes, to E. & F. Construction Co., 94 Wells St., Bridgeport. Estimated cost $40,000 or more.

Ind., Muncie—Warner Gear Co., plans the construction of 2 story, 300 x 400 ft., factory, including power plant and machine shop on Rd. 67, 4 miles west of here. Estimated cost $500,000. Owner builds by private contract. Machinery for the manufacture of automobile transmissions will be required.

Kan., Wichita—Stearman Aircraft Corp., L. Stearman, Pres., 601 East 35th St., awarded contract for the construction of a group of aircraft factory buildings, including boiler room and power plant at South Hillside Rd., to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $350,000.

Mass., Great Barrington—Rising Paper Co., c/o L. R. Howes, Archt., c/o Stratmore Paper Co., West Springfield, is having plans prepared for the construction of a 3 story, 85 x 175 ft. finishing plant. Estimated cost $100,000.

Mass., North Billerica — Talbot Mills, F. S. Clark, Pres., will soon let contract for the construction if a textile finishing plant, here. Estimated cost $100,000. Charles T. Main, Inc., 201 Devonshire St., Boston, are engineers.

Mo., Kansas City—Whitaker Battery & Supply Co., 2463 Charlotte St., awarded contract for the construction of a 1 story, 160 x 188 ft. factory, here, to M. Hoffman, 609 Victor Bldg. Estimated cost $75,000.

Mo., St. Louis—St. Louis Portland Cement Co., c/o C. Boettcher, Pres. Ideal Cement Co., Denver National Bank Bldg., Denver, Colo., making preliminary plans for the construction of cement manufacturing plant here, daily capacity 4,000 bbl. Estimated cost approximately $2,000,000.

N. J., Bound Brook—Francisco & Jacobus, Archts., 511 5th Ave., New York, will soon let contract for the construction of a 1, 2, and 3 story, 405 x 410 ft. main building; 1 and 2 story, 100 x 200 ft. manufacturing building; 1 story, 100 x 100 ft. garage and machine shop; 1 and 2 story, 130 x 220 ft. manufacturing Building 2; 1 story, 50 x 100 ft. power house, also storage building, pump house, switch house, etc. at River Rd. and Reading R.R. tracks, here, for Bakelite Corp., 247 Park Ave., New York. Estimated cost $150,000 or more.

N. Y., Endicott—International Business Machine Corp., awarded contract for remodeling present factory buildings, to A. W. Bowie, Binghamton.

Pa., Neville Island—Gulf Refining Co., 21 State St., Pittsburgh, is having plans prepared for the construction of a refinery, including steel tanks and miscellaneous equipment. Estimated cost $1,500,000. Private plans in charge of H. Henderson, Frick Bldg., Pittsburgh.

Ont., Fort William—Fort William Gas Co. (subsidiary of Canadian Terminal Systems, Ltd.), H. A. Johnston, Ch. Engr., 1106 C.P.R. Bldg., Toronto, will receive bids in September, for the construction of a gas and coking plant, here. Estimated cost $500,000.

Ont., London—Canadian Richards-Wilcox Co. of London, awarded contract for the construction of a 1 story, 80 x 80 ft. addition to plant for the manufacture of fire proof fittings, here, to The McEachern Constr. Co. of London.

Ont., Schumaker—McIntyre Porcupine Mines, Ltd., Standard Bank Bldg., Toronto, plans the construction of a 2,000 ton mill for gold mining, including milling and concentrating equipment, electric power, etc. Estimated cost $500,000. Private plans.